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RECONNAISSANCE STUDY INTERSTATE 90 MONTANA-IDAHO BORDER - SALTESE

MONTANA HIGHWAY COMMISSION

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RECONNAISSANCE STUDY

OF

INTERSTATE ROUTE 90

FROM

MONTANA - IDAHO BORDER

TO

SALTESE

PREPARED BY

MONTANA STATE HIGHWAY COMMISSION

PLANNING SURVEY DIVISION

INTERSTATE DIVISION

IN COOPERATION WITH

U. S. DEPARTMENT OF COMMERCE

BUREAU OF PUBLIC ROADS

APRIL 15, 1962

INTERSTATE ROUTE 90 - SALTESE TO MULLAN
CONSOLIDATION OF MONTANA AND IDAHO COST DATA

LINE	DESCRIPTION	LENGTH	TOTAL CONSTR. COST	ANNUAL CONSTR. COST	ANNUAL MAINT. COST	ANNUAL OPERATING COST	TOTAL ANNUAL COST
M-A7	Lookout Pass - 7% Surface	11.174	$9,027,000	$499,281	$39,109	$1,595,635	$2,134,025
I-16	" " " "	5.133	6,200,900	348,868	17,966	882,764	1,249,598
	Total	16.307	15,227,900	848,149	57,075	2,478,399	3,383,623
M-A5	Lookout Pass - 5% Surface	11.100	12,977,000	697,316	38,850	1,581,098	2,317,264
I-17	" " " "	5.170	6,954,500	388,062	18,095	867,342	1,273,499
	Total	16.270	19,931,500	1,085,378	56,945	2,448,440	3,590,763
M-B7	Mullan Pass (Packer Cr.) - 7% Surface	9.030	10,317,000	557,338	31,605	1,322,352	1,911,295
I-3a	" " " " " "	7.519	8,161,000	441,545	26,317	1,159,585	1,627,447
	Total	16.549	18,478,000	998,883	57,922	2,481,937	3,538,742
M-B5	Mullan Pass (Packer Cr.) - 5% Surface	9.301	19,495,000	1,022,399	32,554	1,369,641	2,424,594
I-4	Mullan Pass " " " "	7.727	10,521,600	575,677	27,045	1,245,787	1,848,509
	Total	17.028	30,016,600	1,598,076	59,599	2,615,428	4,273,103
M-C7	Mullan Pass (Ran. Cr.) - 7% Surface	10.352	10,915,000	592,325	36,232	1,506,952	2,135,509
I-3a	" " " " " "	7.519	8,161,000	441,545	26,317	1,159,585	1,627,447
	Total	17.871	19,076,000	1,033,870	62,549	2,666,537	3,762,956
M-C5	Mullan Pass(Ran. Cr.) - 5% Surface	10.803	14,576,000	778,776	37,811	1,583,370	2,399,957
I-4	Mullan Pass " " " "	7.727	10,521,600	575,677	27,045	1,245,787	1,848,509
	Total	18.530	25,097,600	1,354,453	64,856	2,829,157	4,248,466
M-D	St. Regis Pass Tunnel - 2 lane	11.038	8,701,000	481,941	38,633	1,558,447	2,079,021
I-14	" " " " " "	4.490	12,817,500	636,745	81,120	692,691	1,410,556
	Total	15.528	21,518,500	1,118,686	119.753	2,251,138	3,489,577*
M-E	Lookout Pass Tunnel - 2 lane	11.018	9,212,000	507,679	38,563	1,562,802	2,109,044
I-5	" " " " " "	5.350	11,468,000	594,827	40,644	914,937	1,550,408
	Total	16.368	20,680,000	1,102,506	79,207	2,477,739	3,659,452*
M-F	Mullan Pass Tunnel - 2 lane	8.744	10,338,000	557,177	39,970	1,278,347	1,875,494
I-15	" " " " " "	7.690	12,284,700	638,922	46,433	1,170,843	1,856,198
	Total	16.434	22,622,700	1,196,099	86,403	2,449,190	3,731,692*

* Comparative figures for 3-lane tunnel: St Regis Pass -- $3,626,873; Lookout Pass -- $3,731,805; Mullan Pass-$3,795,990
Comparative figures for 2 2-lane tunnels: St Regis Pass--$3,937,961; Lookout Pass--$3,923,380; Mullan Pass--$3,966,294

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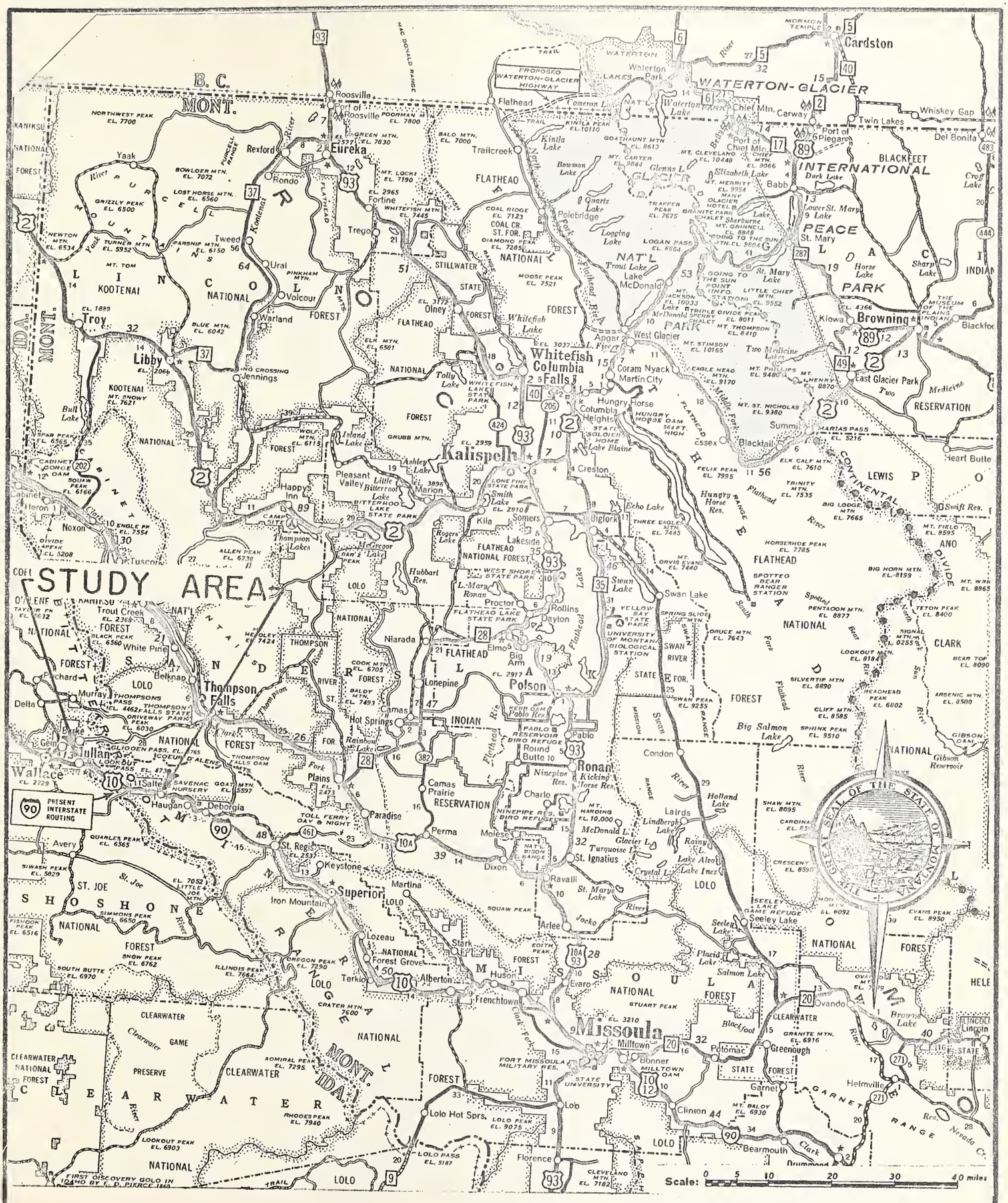
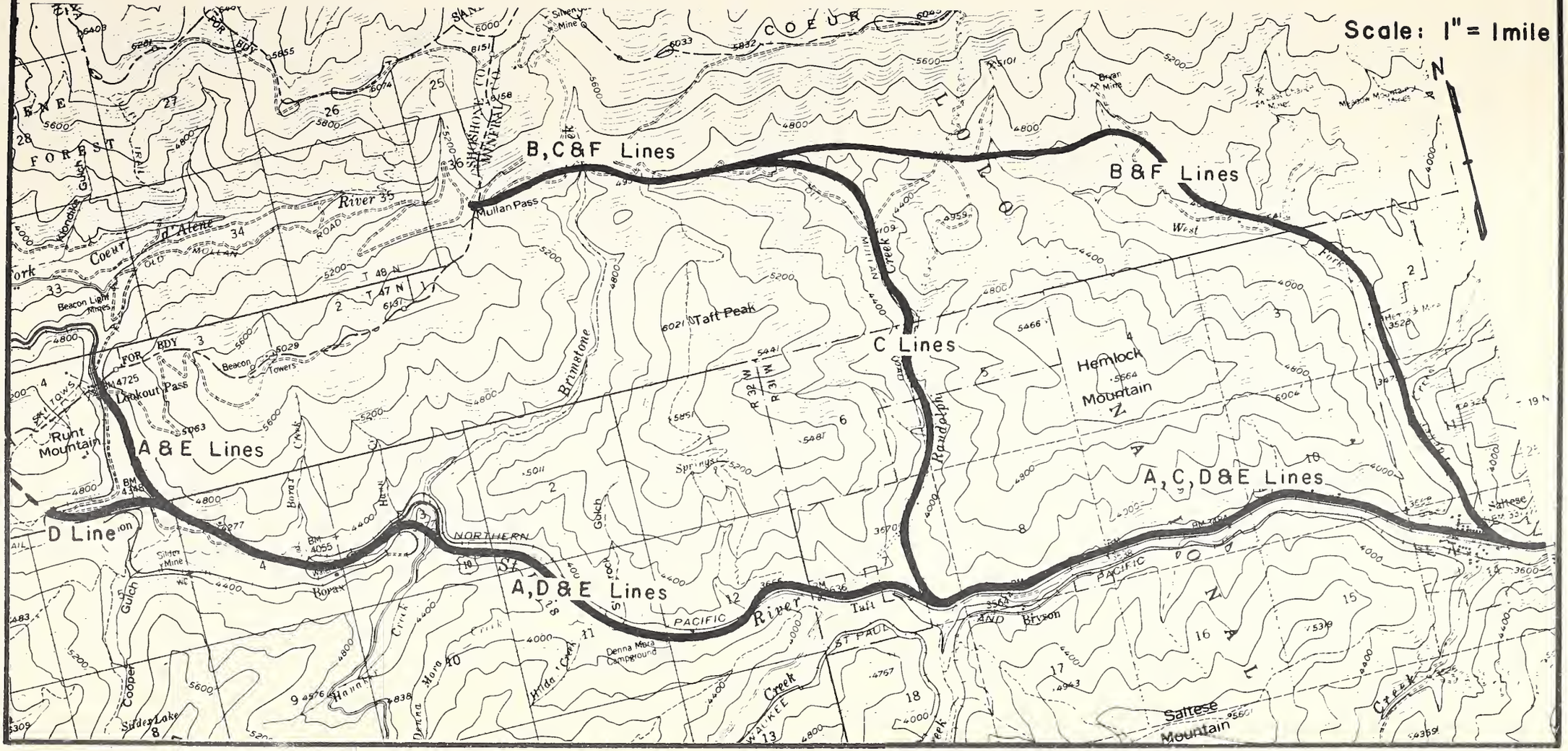


SITUATION MAP

KEY MAP


Scale: 1" = 1mile
N
B,C&F Lines
B&F Lines
C Lines
A&E Lines
A,C,D&E Lines
A,D&E Lines
D Line
Mullan Pass
Lookout Pass
Taft Peak
Hemlock Mountain
Runt Mountain
Saltese Mountain
Beacon
Towers
Beacon Light
Mines
Sidney Mine
Silver Mine
Denna Mora
Campground
Springs
Creek
River
Gulch
Randolph
Brimstone
Cooper
Sidney Lake
Hanna
Walkee
Bryson
Coeur d'Alene
River
ROAD
OLD MULLAN
MILLAN
NORTHERN
PACIFIC
AND
ST PAUL
FOR BDY
T 48 N
T 47 N
R 32 W
R 31 W

INTRODUCTION

Federal Aid Interstate Route No. 90 (U.S. Highway No. 10) presently crosses the Idaho-Montana border on a location through Lookout Pass. The highway in this vicinity was constructed on this location many years ago as being the most favorable line from the standpoint of conditions, standards and finances that prevailed at that time. It is evident, however, that the present highway through this area in both states must be reconstructed to conform to the higher standards which are now prescribed for Interstate highway construction.

Since the new highway must cross the border at a point agreed upon by both states, agreement has been reached among highway officials of both states and the Bureau of Public Roads that a joint study should be made of possible alternate locations for the highway. This report presents an analysis of the feasible locations in the State of Montana. A similar report is to be prepared for locations in Idaho, and the findings of both reports will then be consolidated into a summary report which will review the features involved in both states and offer recommendations concerning the most favorable route throughout the area.

Preliminary investigations of the possible routes were started by officials of the Idaho Department of Highways in 1955. Partial aerial photography was obtained for Idaho in 1958, and after the matter had been reviewed, it was considered that the point had been reached where joint action should be taken between the two states to pursue the matter to a final conclusion.

In line with this decision, a meeting was held in July 1959 which was attended by representatives of the Idaho Department of Highways, Montana State Highway Commission and the Bureau of Public Roads. Between this time and December 1961, a series of meetings were held among the officials concerned which culminated in the following recommendations:

1. Although several alternate locations would be considered in both states, many of the alternates could be eliminated during preliminary phases without going into full scale analyses. During this process, the alternates could be reduced to the best surface route through Lookout and Mullan passes and the best tunnel routes through Lookout, Mullan and St. Regis passes. It was also agreed that the surface routes through Lookout and Mullan passes should include separate lines with 7% maximum grade and 5% maximum grade. Points of common terminus were established for all routes near Mullan, Idaho and Saltese, Montana

2. Design criteria were agreed upon at these meetings, and agreement was reached regarding the unit prices for construction items to be used in both states in estimating the total construction cost for the various routes. The costs of construction engineering and contingencies

were not to be shown as separate items but were to be included in the unit prices for the other construction cost items.

3. Detailed geologic and drainage investigations were to be made, with the results being summarized in the main report.

4. The following service lines were agreed upon for amortizing the cost of principal construction items:

Right-of-way	50 years
Grading and drainage	40 years
Base and surface	20 years
Traffic services	20 years
Structures	50 years
Tunnels	50 years

Interest was established at 4% in selecting the capital recovery factor.

5. Maintenance cost figures were set at $3,500 per mile, consisting of $1,000 per mile for general maintenance and $2,500 per mile for special maintenance, snow removal and sanding.

6. Estimates for tunnel construction and maintenance were to be developed by Idaho personnel.

7. In computing vehicle operating costs, traffic volumes of 1975, as contained in the Section 104 (b) 5 Study, were to be used. These figures consisted of 3,500 vehicles per day, with 10% being trucks and buses.

8. In the absence of definitive truck operating cost figures from other sources, it was decided that Idaho personnel would prepare these data with special attention being given to gradient as an important feature in the analysis. The suggested figures were to be reviewed and approved by Montana personnel.

9. Passenger car operating costs were to be prepared by Montana personnel, also with appropriate adjustment for grades. It was agreed that the basic figures in the AASHO manual on this subject would provide the foundation for the preparation of these costs. The figures were to be reviewed and approved by Idaho personnel.

10. Each state would prepare a separate report for routes and conditions pertaining to that state. The annual cost of construction, maintenance and vehicle operation would be summarized for each route as an indication of the economic merit of the alternate locations.

11. The principal data for each route would then be consolidated in a summary report where the alternates in both states could

be compared. This report would show which consolidated route between Mullan, Idaho and Saltese, Montana would be most favorable on the basis of economic considerations of construction costs, maintenance costs and vehicle operating costs. Other features to be considered would also be described in this summary report.

DESCRIPTION OF THE AREA

In the preliminary meetings concerning the problem, it was evident that the area of investigation could be confined to the country between Saltese, Montana and Mullan, Idaho. All alternate locations in both states would have common termini in the vicinity of these two places.

A map in the front of this report shows a broad region in northern Idaho and western Montana surrounding the Mullan-Saltese area. Another map shows the Mullan-Saltese area in more detail. The purpose of this section of the Montana report is to present background material on the area in Montana between Saltese and the Idaho border.

Saltese, the eastern terminus of the route analyses, is located in the valley of the St. Regis River. The name of the river was given by early missionaries in honor of St. Regis DeBorgia. The name DeBorgia has been given to a small community about nine miles east of Saltese, and a larger town about fifteen miles east of DeBorgia is known as St. Regis.

Saltese has an estimated population of 85 persons. It is a small community with facilities catering to highway traffic. Hunting, fishing and other recreational activities contribute to the economy of the area. It is located in the western part of Mineral County, which derives its name from the prevalence of mineral deposits in the general area. Although mining is of much less importance than it is on the Idaho side of the border, there was considerable activity in this region in the early days.

The present highway east of Saltese follows the general location of the historic Mullan Road, which was located by Capt. John Mullan from Fort Benton, Montana to Walla Walla, Washington during the period of 1855 to 1862. History reports that his group spent the winter of 1859 near St. Regis. The easy grades up the river valleys in western Montana encouraged use of this route by early travelers, and it was natural that this same valley was to be used by railroads when they were built through the area at a later date.

Although the main line of the Northern Pacific Railway is located in the Clark Fork River valley to the north of the St. Regis River valley, this company has constructed a branch line between St. Regis and Wallace, Idaho. This line is located in close proximity to the present highway between Saltese and Lookout Pass.

The main line of the Chicago, Milwaukee, St. Paul and Pacific Railway is also located in the same valley, but it leaves the present highway about four miles west of Saltese on a different line enroute to Spokane, Washington.

The existence of these railroad lines in the St. Regis valley complicates somewhat the problem of locating a highway through the area which must be constructed to the standards prescribed for Interstate highway construction.

DESCRIPTION OF ROUTES

On the Montana side of the border, three main locations appeared to be feasible and worthy of investigation. These locations were controlled by the existence of natural passes across the border. The most northerly crossing is located at Mullan Pass. This pass was used by the Mullan Road, and it can be reached by way of two drainage courses in Packer Creek and Randolph Creek.

Both of these drainage courses are quite narrow and would present difficult construction problems. Routes through these drainage courses would be shorter than routes through Lookout Pass, but this advantage would be more than offset by greater lengths on connecting routes on the Idaho side of the border. With an elevation of 5,180 feet, Mullan Pass would be about 455 feet higher than the elevation of Lookout Pass at 4,725 feet.

The location through Lookout Pass follows along the general alignment of the present highway. Some difficult construction will also be encountered along this line, but the terrain is more open than the Packer Creek or Randolph Creek lines.

An alternate proposal involves following the present highway, or Lookout Pass lines to a point about one mile below the crest of the pass. At this point the line would veer to the west and follow a short drainage course to a tunnel site near St. Regis Pass. St. Regis Pass has an elevation of 4,920 feet, but the highest (east) portal of this tunnel would be located at about 4,450 feet of elevation.

Through the Packer Creek, Randolph Creek and Lookout Pass locations, two separate lines were investigated. One line has grades not exceeding 7% and the other line has grades not exceeding 5%. In addition, tunnel routes were investigated through Lookout and Mullan passes. The highest points were reached at the east or south portals of these routes at an elevation of about 4,600 feet for Lookout Pass and about 4,900 feet for Mullan Pass.

Between Saltese and the Idaho border, local development is of minor importance along any of the alternate routes. There is very little development on Packer Creek or Randolph Creek. Along the present highway to Lookout Pass,there is a small railroad establishment at Taft, and a ski area is located near the crest of Lookout Pass.

Detailed descriptions of each alternate are given in the following:

A-7 LOOKOUT PASS - UP TO 7% GRADES

This is a surface route, having not more than 7% grades, starting at the Montana-Idaho border at Lookout Pass, at an elevation of about 4,710 feet, and extending along the general location of the present highway to the point of common terminus about one mile east of Saltese.

The route would cross the pass through a cut about 40 feet deep. After the passage through the cut, the route would begin a 6.5% down grade extending about 1.9 miles. It would then reduce to a 4.0% grade for about 0.4 miles. For the remainder of the route, the grades would not be over 3.0%.

For the first 1.7 miles from Lookout Pass, the route would follow along the hillside on about the same location as the present highway. It would then reach a point more or less on the valley floor, continuing to follow the general location of the present highway to a point near Brimstone Creek where the new line would depart from the present highway on a deep cut of about 170 feet through a high ridge at this point. Beyond this point, only minor cuts are encountered, and the route follows a line of moderate construction problems.

This line crosses the branch line of the N.P. Railway on an overpass near Borax Creek. It recrosses the railroad on another overpass about one mile east of the Denna Mora Campground.

From Lookout Pass to Taft, the line overlies the present highway for the most part. From Taft to Saltese, the line is mostly above the present highway. At places, it will be necessary to move a power line through this area.

A full diamond-type interchange will be constructed near Saltese to serve this community. In order to obtain sufficient width for this interchange, it will be necessary to relocate the N.P. Railway tracks for a distance of about one mile in the Saltese area.

The maximum grade on this route is 6.5%; the weighted average of all grades is 2.44%. The maximum curve is 5 degrees; the weighted average of all curves is 3 degrees, 7 minutes. The total length of the route is 11.174 miles, with all of it being four-lane construction. The route connects to Idaho Route 16 at Lookout Pass.

Plan and profile sheets for this route are contained in Exhibits 1 to 10, inclusive. Geologic data are shown in Exhibits 45 to 52, inclusive.

A-5 LOOKOUT PASS - UP TO 5% GRADES

This line was investigated in the attempt to establish a location that would have grades not exceeding 5%. Starting at the Saltese end, the

route is coincident with Route A-7 for about 8.0 miles to a point about 0.3 miles east of Brimstone Creek. At this point Route A-5 deviates from the common line and starts to climb on a continuous 5% grade to the top of Lookout Pass. Being on a higher grade than Route A-7, it cuts through the ridge near Brimstone Creek with a 130 foot cut, as compared with a 170 foot cut for the A-7 line.

Several other deep cuts are involved on the approach to Lookout Pass in the attempt to maintain a line not exceeding 5% grades. The maximum elevation is about 4,640 feet.

This line also involves two crossings of the railroad. The overpass near the Denna Mora Campground is located at the same place as on the A-7 line. The second crossing is made at a point near the deep cut at Brimstone Creek. This is also an overpass.

The maximum grade for this route is 5%; the weighted average of all grades is 2.44%. The maximum curvature is 5 degrees; the weighted average of all curves is 3 degrees, 4 minutes. The A-5 Route connects to Idaho Route 17 at Lookout Pass. The total length of the route is 11.100 miles. As with all routes, this location involves four-lane construction throughout.

Plan and profile sheets are included in Exhibits 11 to 13 which show the data for the section of Route A-5 that is not coincident with Route A-7. Exhibits 3 to 10 of the A-7 line show coincident sections. Geologic data are shown in Exhibits 45 to 52.

B-7 PACKER CREEK TO MULLAN PASS - UP TO 7% GRADES

The Packer Creek Canyon was investigated as a possible location for the highway with Mullan Pass as the control point for crossing the state line. The B-7 route was selected as a line having grades not exceeding 7%. This route crosses Mullan Pass at an elevation of about 5,120 feet through a cut about 45 feet deep. The area in the vicinity of the pass is relatively flat in comparison with most of the terrain in this vicinity. Grades are kept below 4.5% for the first 3.8 miles. A steep descent then begins into the main canyon with 7% grades for about 2.7 miles. For the remainder of the distance to the common terminus east of Saltese, the grades are fairly moderate.

Several deep cuts are involved in the descent into the canyon. Since this location is well up on the hillside, it may be expected that much of the excavation will be in rock.

The routes up Packer Creek are on completely separate locations from the present highway and railroad lines so there is no conflict with these facilities. There may be some conflict with power lines, but this will be of minor importance. Saltese will be served with a full diamond-type interchange; however, the terrain permits it to be located so that it will not require a railroad relocation as is required for the A-7, A-5, C-7, C-5, D and E lines.

The maximum grade on this route is 7%; the weighted average grade

is 3.91%. The maximum curvature is 6 degrees; the weighted average of curves is 2 degrees, 54 minutes.

The route length is 9.030 miles in Montana, being all of four-lane construction. This route connects with Idaho Route 3a.

Plan and profile sheets are contained in Exhibits 14 to 21. Geologic data are shown in Exhibits 53 to 59.

B-5 PACKER CREEK TO MULLAN PASS - UP TO 5% GRADES

This line was selected as an alternate to the B-7 line in the attempt to develop a suitable location with grades not exceeding 5%. It is coincident with the B-7 line for about the first 3.2 miles leading from Mullan Pass. Grades are not over 4.5% for the first 3.8 miles, then the descent into the canyon is begun on 5% grades for about 3.8 miles. Moderate grades are encountered on the remaining distance of about 1.7 miles to the common terminus. About 1.2 miles of the southeastern end of the route is coincident with the B-7 line.

Numerous deep cuts are involved in the first 8.1 miles of the route in order to maintain a location not exceeding 5% grades. Since this is located on the side of the canyon for much of the distance, it can be expected that there will be a substantial amount of rock excavation.

As is the case with the B-7 line, no railroad facilities are involved, and the same interchange layout will be provided at Saltese. The length of the route is 9.301 miles. Four-lane construction is planned.

The maximum grade is 5% and the weighted average grade is 3.79%. The maximum curve is 7 degrees, 30 minutes, with the weighted average curve being 3 degrees, 9 minutes. Plan and profile data are shown in Exhibits 22 to 27 for the non-coincident sections. Exhibits 14 and 15 of the B-7 line show coincident sections. Geologic data are contained in Exhibits 53 to 59.

This line connects with Idaho Route 4 at Mullan Pass.

C-7 RANDOLPH CREEK TO MULLAN PASS - UP TO 7% GRADES

The Randolph Creek Canyon was also investigated as the location for lines leading to Mullan Pass. These lines would follow the same line as Routes A-7 and A-5 for a distance of about 4.3 miles from the common terminus east of Saltese to the mouth of Randolph Creek. They would then follow Randolph Creek Canyon on an approximate north-south line to a point of connection with the Packer Creek lines about 3 miles east of Mullan Pass. From this point to Mullan Pass, the Randolph Creek lines would be coincident with the Packer Creek lines. The old Mullan Military Road followed Randolph Creek when it was constructed in 1859.

The crossing of Mullan Pass is on the same grade and line as the Packer Creek lines. The elevation at the pass is also the same.

The C-7 line has about 2.4 miles of 7% grade, and about 2.0 miles of 4.0% and 4.5% grades. The last 1.2 miles before the junction with the A-7 line has 2.4% grades.

Numerous deep cuts are involved throughout the upper part of Randolph Creek. It appears that a large part of this excavation would be in rock.

In the vicinity of Saltese, the interchange layout and the railroad relocation would be the same as was described for the A-7 line. Since the C-7 line leaves the A-7 line at Randolph Creek, there would be no problem with railroad separation structures which are located farther up the canyon on the A-7 line.

It is planned that a half-diamond interchange will be located at the mouth of Randolph Creek to provide access to the present highway, which is expected to remain in service to Lookout Pass if the new Interstate highway were to be built through Mullan Pass.

The length of the C-7 Route is 10.352 miles. Four-lane construction is involved. It connects to Idaho Route 3a at Mullan Pass.

The maximum grade on this route is 7%; the weighted average of grades is 3.43%. Maximum curvature is 7 degrees, with a weighted average of curves of 3 degrees, 3 minutes.

Plan and profile sheets are contained in Exhibits 28 to 33 for the non-coincident sections. Coincident sections are shown in Exhibits 7 to 10 for the A-7 line. Geologic data are shown in Exhibits 60 and 61 for C lines, Exhibits 49 to 52 of the A lines and Exhibits 53 to 55 for the B lines.

C-5 RANDOLPH CREEK TO MULLAN PASS - UP TO 5% GRADES

This location was selected as a line up Randolph Creek with grades not exceeding 5%. It follows the same location as the B-7 and C-7 lines for about the first mile east of Mullan Pass. Being on the same location as these other routes, it has the same features at the crossing of Mullan Pass. It continues to be coincident with the C-7 line for about an additional 0.3 mile, then it begins a descent into Randolph Creek on a separate location about half-way between the B-7 and C-7 lines. At a point about 2.8 miles east of Mullan Pass, the C-5 line leaves the vicinity of the C-7 line on a long curve which elongates the grade and reduces it to the acceptable 5% maximum. After reaching the vicinity of the canyon floor, the C-5 line follows on a location parallel to the C-7 line but farther up on the hillside. For the last 0.5 mile in Randolph Creek, the C-5 and C-7 lines are coincident.

The interchange layout and railroad location, as described for the A-7 and C-7 lines, would apply to the C-5 line. The C-5 line would also have the same half-diamond interchange at the mouth of Randolph Creek as described for the C-7 line.

The maximum grade would be 5%, with a weighted average of grades of 3.29%. Maximum curvature would be 7 degrees, with weighted average of curves of 3 degrees, 37 minutes.

The total length of the route is 10.803 miles. It is all four-lane construction. It would connect with Idaho Route 4 at Mullan Pass.

Plan and profile data are contained in Exhibits 34 to 39 for the non-coincident sections, with the coincident sections being shown in Exhibits 7 to 10 for the A-7 line. Geologic data are shown in Exhibits 60 and 61 for the C lines, 49 to 52 for the A lines and 53 to 55 for the B lines.

D- ST. REGIS TUNNEL

A preliminary investigation showed that a tunnel through St. - Regis Pass would offer certain advantages for a highway location on the Idaho side of the border. The D line on the Montana side of the border was investigated as a possible location for a route connecting with this tunnel. St. Regis Pass is located about one mile southwest of Lookout Pass.

The D line is coincident with the A-7 line for a distance of about 9.4 miles from the Saltese terminus westward to a point about 1.7 miles southeast of Lookout Pass where the D line veers to the west towards St. Regis Pass. At this point, the D line follows up a separate drainage course that has been used as a switchback by the railroad in the climb to Lookout Pass.

The ascent up this drainage course is achieved on grades running from 3.4% to 5.0%. The route connects to the east portal of the tunnel at a point just below the switchback on the railroad track. This portal is located at about 4,460 feet of elevation.

The total length of the route, excluding the tunnel portion in Montana, is 11.038 miles. The total length of the tunnel is to be included in the Idaho report. It appears, however, that about 59% of the tunnel length will be located on the Montana side of the border.

The D line connects with Idaho Route 14.

The maximum grade on the D line is 5%; the weighted average of grades is 2.03%. The maximum curvature is 5 degrees; the weighted average of curves is 3 degrees, 20 minutes.

Plan and profile sheets are included in Exhibits 40 and 41 for

the section of the D line that is not coincident with the A-7 line. The section of the D line that is coincident with the A-7 line is shown in Exhibits 3 to 10. Geologic data are shown in Exhibits 45 to 52 for the A lines.

E- LOOKOUT PASS TUNNEL

The E line was investigated as a route to Lookout Pass which would connect to a tunnel under the pass. This tunnel would be located a short distance east of the present highway crossing the pass. The Montana portal of the tunnel would be located at an elevation of about 4,600 feet.

About the first 1.9 miles of the E line south of the tunnel portal would be on an independent line with a grade of 5.4%. The remainder of the route would follow the A-7 line and would have the same characteristics which were described for that line.

The total length of the E line is 11.018 miles, excluding the portion of the tunnel that is on the Montana side of the border. The length of the Montana side of the tunnel will be included in the Idaho report. It appears that about 45% of this tunnel will be located on the Montana side of the border.

The E line connects with Idaho Route 5.

Throughout the total length of the D line, the maximum grade is 5.4% and the weighted average of grades is 2.26%. The maximum curve is 5 degrees, with a weighted average of curves being 2 degrees, 57 minutes.

Plan and profile data are contained in Exhibits 42 and 43 for the E line and Exhibits 3 to 10 for the A-7 line. Geologic data are contained in Exhibits 45 to 52 for the A lines.

F- MULLAN PASS TUNNEL

The F line was investigated as a route connecting to the proposed tunnel under Mullan Pass. The portal of this tunnel on the Montana side of the border is located about 4,900 feet.

The F line climbs on a 4% grade for about 0.5 mile after leaving the tunnel portal. It then descends on a 4.5% grade for about 0.5 mile to a point of connection with the B-7 line. For the remainder of the distance it follows the B-7 line to a point of connection with the A-7 line and then follows the A-7 line to the common terminus east of Saltese.

The total length of the route is 8.744 miles, excluding the tunnel portion. It appears that about 31% of the tunnel will be located on the Montana side of the border.

The F line connects with Idaho Route 15.

Throughout the total length of the F line, the maximum grade amounts to 5%. The weighted average of grades is 3.86%. Maximum curvature is 6 degrees. The weighted average of curves is 2 degrees, 49 minutes.

Plan and profile data for the separate section of the F line are shown in Exhibit 44. The data for the sections coincident with the B-7 and A-7 lines are shown in Exhibits 15 to 21 for the B-7 line and Exhibit 10 for the A-7 line. Geologic data are included in Exhibits 53 to 59 for the B lines.

GENERAL DATA

Table No. 1 presents a comparison of the number and length of grades for the various alternate routes. It may be noted that the D and E lines (tunnel routes) have the lowest weighted average grades. The A-7 and A-5 lines have the next best ratings on average grade.

Table No. 2 shows a comparison of the curvature on the various routes. This table shows that the B-7 and F lines have fewer curves and also lower figures for the weighted average of curves.

The A-7, A-5, B-7, B-5, D, E, and F lines are so located that they will benefit from predominant southern exposure. This should help to reduce the cost of maintenance activities relating to snow removal and sanding. The sections of the C-7 and C-5 lines within Randolph Creek Canyon are on a direct north-south line, which will give the routes a western exposure for the most part.

The A-7, A-5, D and E lines are located to a considerable degree on alluvial material, and this feature should reduce the excavation problems. Much of the location of the B-7, B-5, C-7, C-5 and F lines is on the hillside where it may be expected that considerable bedrock will be encountered with attendant excavation problems.

The A-7, A-5, D and E lines are located on or in close proximity to the present highway. This will present the problem of maintaining the traffic flow during the construction period. The B-7 and B-5 lines in Packer Creek are on new location, so the maintenance of traffic will not be a problem. The same feature applies in lesser degree to the C-7 and C-5 lines.

It should be pointed out, however, that the problem of maintaining traffic on the lines overlying the present highway is offset to some degree by the consideration that it will be necessary to keep the present highway open to service for local and recreational traffic in the event that the new highway were to be located in Packer or Randolph creeks.

The Geologic exhibits show that the entire area under investigation has been extensively faulted. It appears, however, that the lines in proximity to the present highway have fewer fault lines and shear zones to contend with. The avalanche activity on the Montana side of the border appears to be less than such activity on the Idaho side of the border. Possibilities of slides exist on all lines in Montana, but the problem appears to be of minor importance.

TABLE NO. 1

COMPARISON OF GRADES FOR ALTERNATE ROUTES

% GRADE	A-7 LOOKOUT PASS		A-5 LOOKOUT PASS		B-7 PACKER CREEK		B-5 PACKER CREEK		C-7 RANDOLPH CREEK		C-5 RANDOLPH CREEK		D ST. REGIS TUNNEL		E LOOKOUT TUNNEL		F MULLAN TUNNEL	
	No.	Feet	No.	Feet	No.	Feet	No.	Feet	No.	Feet	No.	Feet	No.	Feet	No.	Feet	No.	Feet
0.0	1	3000	1	3000									1	3000	1	3000		
0.5	1	5600	1	5600					1	3340	1	3340	1	5600	1	5600		
0.8	1	1200	1	1260	1	2100	1	2100	1	1260	2	3190	1	1200	1	1200	1	2100
1.0	2	7400	2	7400					1	3400	1	3400	2	7400	2	7400		
1.2	1	2800	1	2740					1	2740	1	2740	1	2800	1	2800		
1.5	2	11400	2	11400	1	4000			1	6800	1	6800	2	11400	2	11400	1	4000
1.8					1	1630	1	1630									1	1630
2.0	1	3800	1	3800	1	1400	2	3775	1	3800	1	3800	1	3800	1	3800	1	1400
2.1					1	3280											1	3280
2.2	1	1600	1	1600	1	1250	1	1250	1	1600	1	1600	1	1600	1	1600	1	1250
2.4									1	5820								
2.6							1	4200										
3.0	2	10000	2	4368	1	12540	1	8230					2	10000	2	10000	1	12640
3.4													1	4300				
4.0	1	2200							2	8340			1	1720	1	1700	1	2895
4.4													1	5180				
4.5					2	7870	2	7870	2	5300	2	10550					1	3315
5.0			3	17442	1	2425	1	20055			1	21620	1	280			1	2425
5.4															1	9675		
6.0	1	5000																
6.5	1	5000																
7.0	—	—	—	—	1	11185	—	—	2	12260	—	—	—	—	—	—	1	11235
TOTAL	15	59000	15	58610	11	47680	10	49110	14	54660	11	57040	16	58280	14	58175	11	46170
AVERAGE GRADE		2.44		2.44		3.91		3.79		3.43		3.29		2.03		2.26		3.86

TABLE NO. 2

COMPARISON OF CURVATURE FOR ALTERNATE ROUTES

CURVES Deg.	Min.	A-7 LOOKOUT PASS No.	Feet	A-5 LOOKOUT PASS No.	Feet	B-7 PACKER CREEK No.	Feet	B-5 PACKER CREEK No.	Feet	C-7 RANDOLPH CREEK No.	Feet	C-5 RANDOLPH CREEK No.	Feet	D ST. REGIS TUNNEL No.	Feet	E LOOKOUT TUNNEL No.	Feet	F MULLAN TUNNEL No.	Feet
1	00					3	4830	3	5150			1	930			1	2160	3	4850
1	30	3	4060	4	4410					1	810	1	810	2	2620	2	2620		
2	00	5	4530	2	2010	4	4110	5	5720	6	5820	6	5880	5	4430	6	6520	4	4990
2	30	3	2790	4	4730	1	540	1	540	6	8520	3	1750	2	1340	1	570		
3	00	2	1760	4	3330	1	1000	2	2730			1	1500	2	1760	3	2380	1	1000
3	30	5	5320	5	5720	7	9410	2	3270	5	5670	7	7710	6	5740	5	5320	6	8150
4	00	4	3590	3	2720	2	1440	4	2540	1	620	3	3080	3	3890	2	2520	1	820
4	30	1	830											1	830	1	830		
5	00	3	3770	4	3695	1	980	2	2280	2	1620	1	900	4	4840	3	3770	1	980
6	00					1	1260	1	1260									1	1260
7	00									1	1490	3	4470						
7	30							2	1700										
TOTAL CURVES		26		26		20		22		22		26		25		24		17	
FEET IN CURVES			26650		26615		23570		25190		24550		27030		25450		26690		22050
AVERAGE OF CURVES			3-07		3-04		2-54		3-09		3-03		3-37		3-20		2-57		2-49
AVERAGE CURVE FOR ROUTE			1-24		1-24		1-26		1-37		1-22		1-43		1-27		1-21		1-21

DRAINAGE REPORT

Most of the terrain on the Montana side of Lookout Pass receives approximately three-quarters as much total precipitation as the west side of the pass. Also, the topography is less steep and less shaded than the west side. Snow cover is reduced as a result of lack of precipitation as well as having better thawing conditions. Having less snow pack or stored precipitation causes much lower spring runoffs from rain or snow.

Comparison between the actual 50 year frequency runoffs for several representative areas east of the divide gave data with which a curve was plotted. (See Fig. 1). This curve was compared with a curve obtained from Mr. L. Herr's (Hydraulic Engr. of the B. P. R.) "Simplified Method for the Hydraulic Design of Culverts" and was found to give slightly lower flows. Plotting of the Idaho report flow curves showed a similar difference with the Idaho side giving greater flows. Also compared was the runoff capacity of pipes through the existing road for the different drainage basins, and quite a number of the capacities agreed with the curve.

Records on the main stream of the St. Regis River are very sparse and are not sufficient to obtain a frequency curve for that stream. A peak flow in 1917 shows 7,740. c.f.s. for the drainage area of 300 square miles at St. Regis. This flow, when plotted, does plot very near to the curve as drawn.

The alternate routes as shown on the accompanying maps can be assumed to have the same runoff curve apply to all three routes as they are all in similar topography except for elevation. Some bridge crossings are involved as well as pipe culverts and these openings were sized both by the curve and the existing bridges.

Use of pipe sizes similar to those agreed upon with the State of Idaho caused some deviation from computed sizes, but it is necessary in order to keep the cost figures relative on the routes when considering an entire Idaho-Montana route.

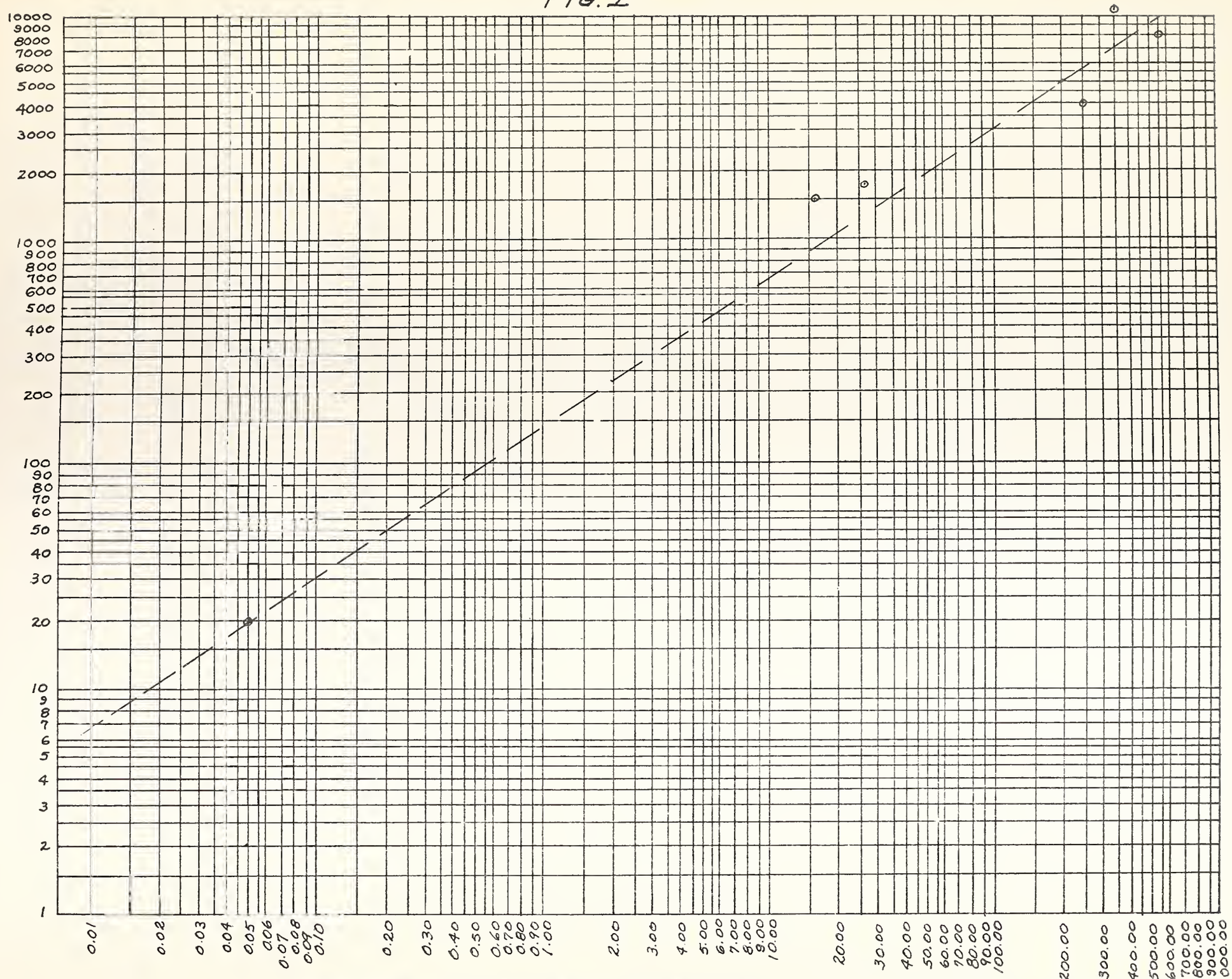
Lines A_7, B_7, and C_7 follow the routing shown on the maps. Drainage areas and flows, as noted in the attached sheets, apply to these routes. Other routes being studied cross the same areas without much change in flow, due to the similarity of the alternates.

DRAINAGE AREAS

Line "A" *			Line "B" *			Line "C" *		
Area No.	Drainage Area Sq. Mi.	Q c.f.s.	Area No.	Drainage Area Sq. Mi.	Q c.f.s.	Area No.	Drainage Area Sq. Mi.	Q c.f.s.
A_1	3.7	340	B_1	0.2	50	C_1	0.5	90
A_2	0.3	65	B_2	0.7	120	C_2	0.2	50
A_3	0.3	65	B_3	0.4	80	C_3	0.2	50
A_4	0.1	30	B_4	0.3	65	C_4	0.3	65
A_5	1.7	200	B_5	0.2	50	C_5	0.7	120
A_6	0.6	110	B_6	0.2	50	C_6	1.3	170
A_7	0.3	65	B_7	0.2	50	C_7	0.2	50
A_8	0.7	120	B_8	0.2	50	C_8	0.2	50
A_9	0.3	65	B_9	0.2	50	C_9	0.4	80
A_{10}	0.2	50	B_{10}	0.6	110	C_{10}	0.5	90
A_{11}	0.2	50	B_{11}	0.1	30	C_{11}	0.4	80
A_{12}	0.4	80	B_{12}	0.8	130	C_{12}	0.8	130
A_{13}	1.8	220	B_{13}	0.5	90	C_{13}	0.1	30
A_{14}	0.1	30	B_{14}	0.3	65	C_{14}	0.7	120
A_{15}	4.4	370	B_{15}	1.3	170	C_{15}	0.1	30
A_{16}	0.4	80	B_{16}	0.1	30	C_{16}	0.2	50
A_{17}	0.2	50	B_{17}	0.1	30			
A_{18}	1.4	180	B_{18}	2.8	290			
A_{19}	0.6	110	B_{19}	0.1	30			
A_{20}	0.5	90	B_{20}	10.4	680			
A_{21}	0.1	30	B_{21}	0.6	110			
A_{22}	0.2	50	B_{22}	0.2	50			
A_{23}	0.2	50	B_{23}	0.2	50			
A_{24}	0.1	30	B_{24}	0.2	50			
A_{25}	0.1	30						
A_{26}	0.6	110						
A_{27}	0.8	130						
A_{28}	4.7	400						
A_{29}	4.3	360						
A_{30}	6.9	510						
A_{31}	0.3	65						
A_{32}	0.3	65						
A_{33}	0.3	65						
A_{34}	0.5	90						
A_{35}	0.2	50						
A_{36}	0.3	65						
A_{37}	0.7	120						
A_{38}	0.3	65						
A_{39}	0.6	110						
A_{40}	0.2	50						
A_{41}	0.3	65						
A_{42}	0.4	80						
A_{43}	0.2	50						
A_{44}	0.4	80						
A_{45}	0.2	50						
A_{46}	18.2	50						

* Note: Alternate lines are so nearly coincident that a common drainage area is used.

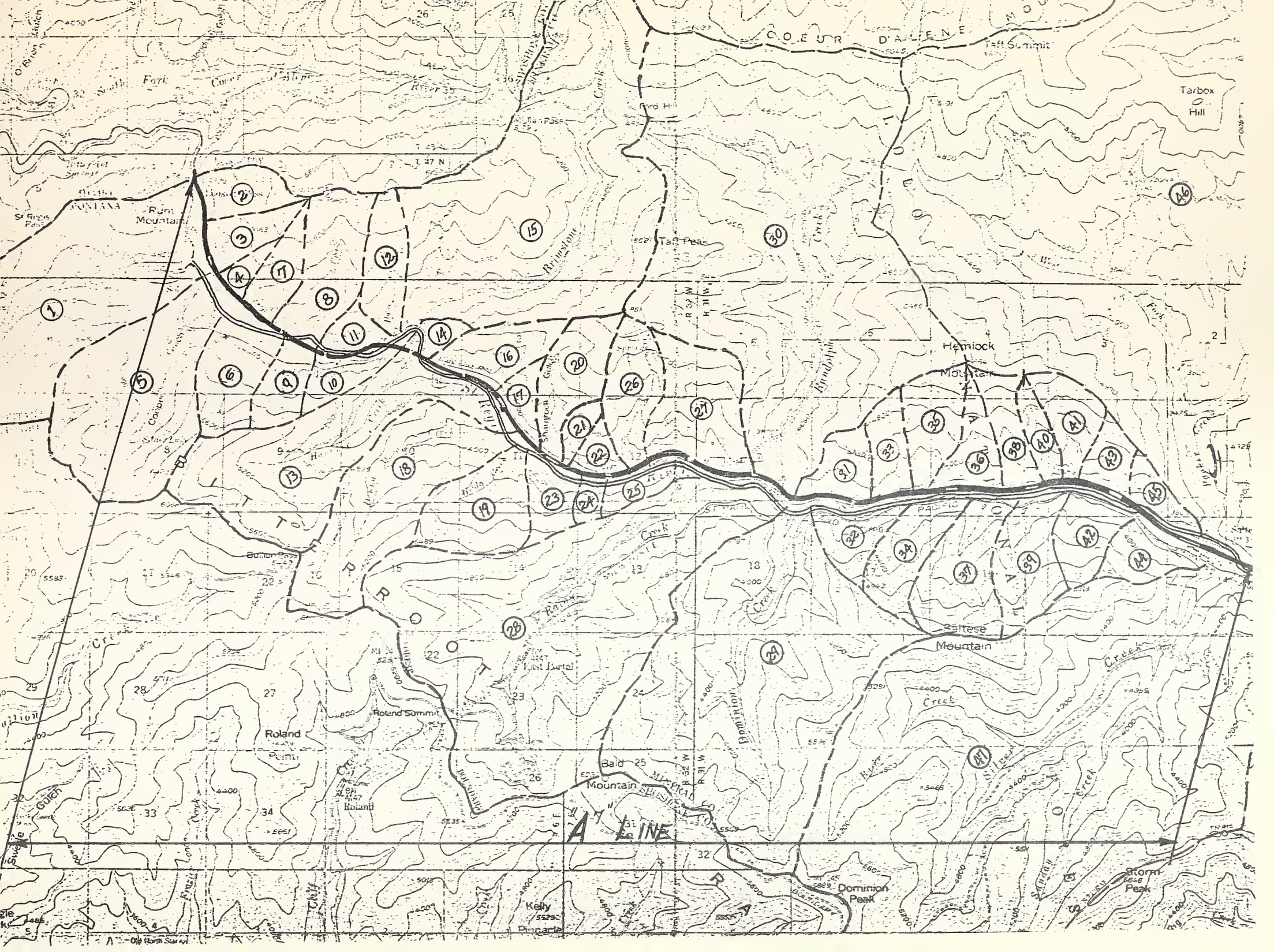
FIG. 1

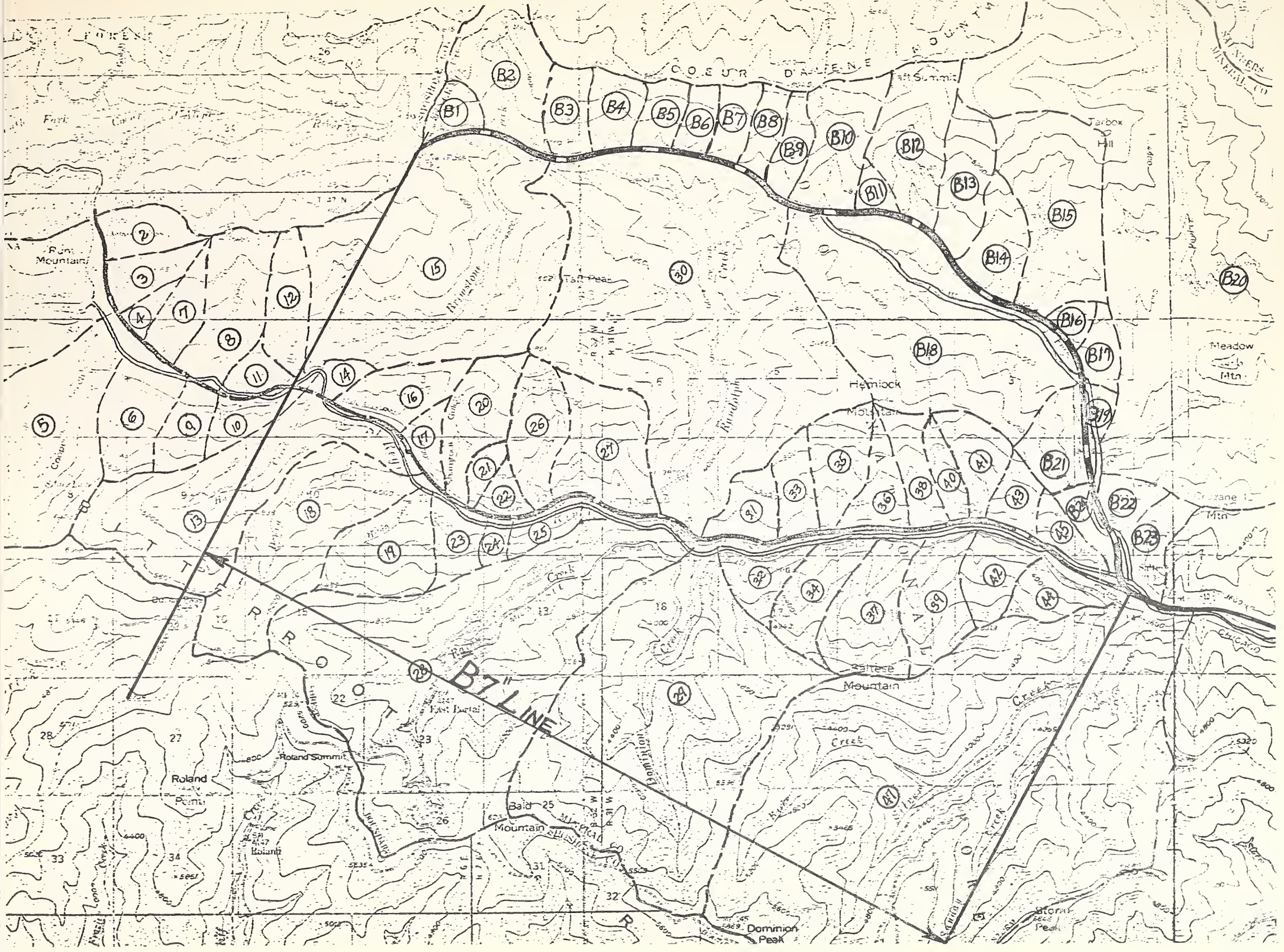


50 YEAR FREQUENCY RUNOFFS

DRAINAGE AREA - SQUARE MILES

LOOKOUT PASS ROUTES
SALTESE - IDAHO LINE
I 90 - 1 (10)


COEUR D'ALENE
Taft Summit
Tarbox Hill
Ruby Mountain
Taft Peak
Hemlock Mountain
Baldy Mountain
Roland Summit
Roland Point
Dominion Peak
Storm Peak
Kelly Pinnacle
Bullion Pass
"A" LINE
T 47 N
R 32 W
R 31 W
R 30 E


B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
B14
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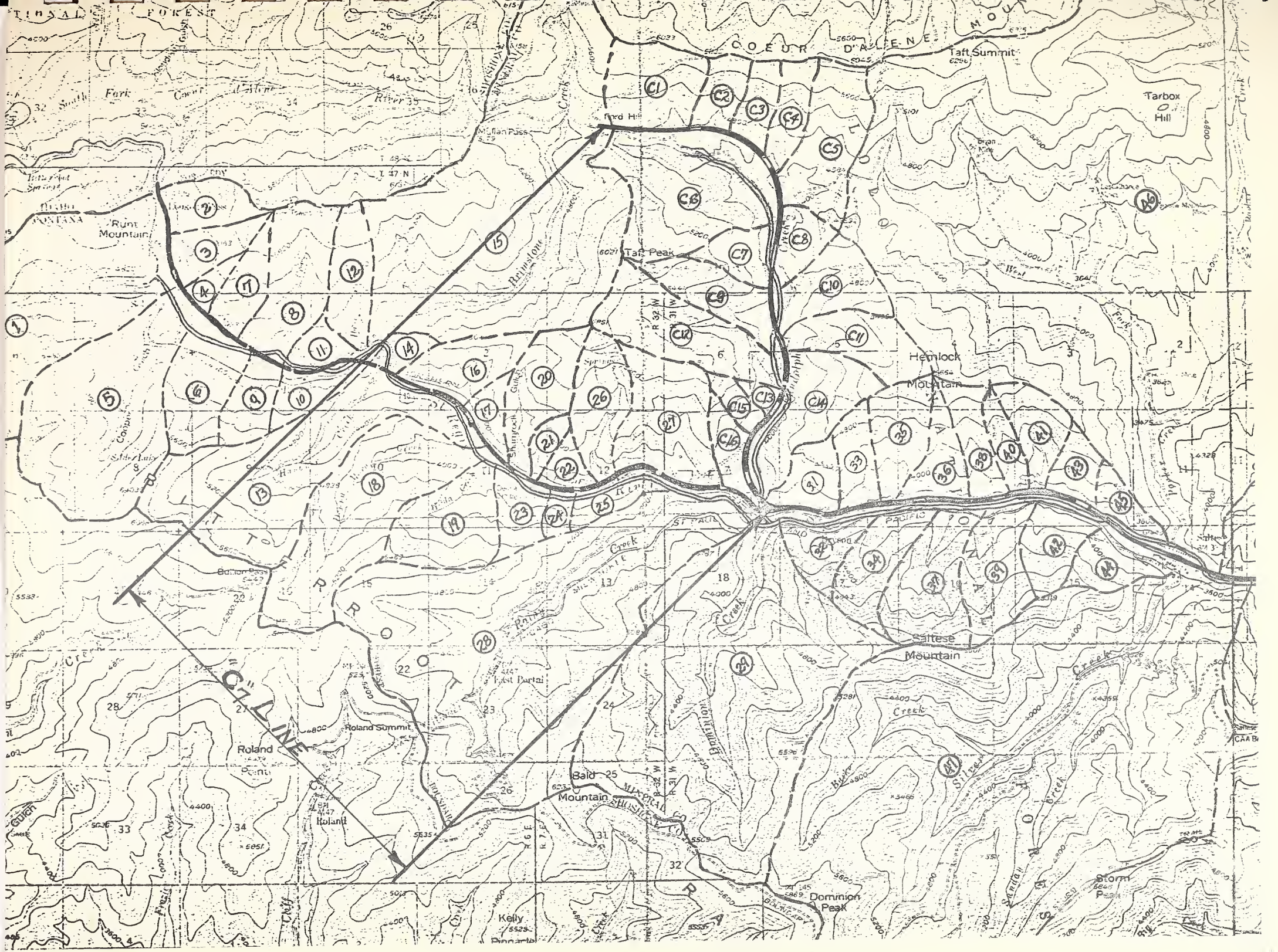
B16
B17
B18
B19
B20
B21
B22
B23
"B7" LINE
COEUR D'ALENE
Tarbox Hill
Meadow Mtn
Hemlock Mountain
Maltese Mountain
Roland Point
Roland Summit
East Buttal
Bald Mountain
Dominion Peak
Ram Mountain
Tall Peak
Brimstone Creek
Rundolph Creek
Chicago Creek


C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
"C7" LINE
Taft Summit
Tarbox Hill
Taft Peak
Hemlock Mountain
Saltese Mountain
Roland
Roland Summit
Bald Mountain
Dominion Peak
Storm Peak
Kelly
Runt Mountain
Ford Hill
Bunker Peak
Coeur d'Alene Mountains
Bitterroot Mountains
Saint Paul Creek
Silver Creek
Bitterroot Range

GEOLOGIC REPORT

PURPOSE AND METHOD OF STUDY

This study was undertaken to provide geologic and soils information to help determine the best routing of the Interstate highway from Mullan, Idaho, to Saltese, Montana.

All the published geologic reports on the area were read and studied. A field reconnaisance was made. The formation, description and petrographic analysis are taken from "Reconnaisance Geology of Western Mineral County, Montana, by Wallace and Hosterman, Geological Survey Bulletin - 1027 - M."

A detailed geologic map was made for the strip maps of each route. Strikes and dips were noted on all outcrops within 200 feet of the proposed center lines, and station to station backslope recommendations were made.

GEOLOGIC HISTORY AND GENERAL FEATURES

The entire area being investigated is underlain by sedimentary beds of the Belt Series, a series of Precambrian, or Proterozoic age. The formations have no fossils and have been divided on petrographic difference. The fine points of such differences being of no consequence in this study, the divisions used by Wallace and Hosterman were adopted without further investigation.

Wallace and Hosterman made a study of 25 thin sections of rocks including typical specimens from each formation. They found that many of the rocks indentified in the field as argillites were really fine grained quartzites. The dominant mineral in all the formations is quartz, much of it very fine grained, from 0.01 to 0.03 mm in diameter, (medium silt size), with lesser amounts of sericite, chlorite and biotite and occasional grains of magnetite and plagioclase feldspar.

In the descriptions which follow, colors are classified according to the system employed in the "Rock Color Chart" (Goddard and others, 1948) distributed by the National Research Council.

The formations of the Belt Series underlying the area covered by this study from oldest to youngest are three: The Burke and Revett formations, undifferentiated; The St. Regis Formation, and the Wallace Formation. The following descriptions are abridged from Wallace and Hosterman:

Burke and Revett Formations

See Figure 1A

South of the Osburn Fault Zone, the quartzites of the Burke and Revett formations are typically fine grained, somewhat argillaceous quartzites, generally a light gray of low chroma or greenish gray (5GY5-6/1). Bedding thicknesses are usually more than one foot and range up to 8 or 10 feet. The most common thicknesses are between 1 and 4 feet. White vitreous quartzites characteristic of the Revett quartzite in the Coeur d'Alene District

are rare. Nowhere south of the Osburn Fault was the base of the quartzite section of the Burke and Revett formations found, but the top is well exposed in many places.

In Mineral County, the contact between the Burke and Revett and the St. Regis formations has been chosen so that the principally argillaceous beds are above and the principally quartzitic beds are below the contact. It should be noted that on many maps of the Coeur d'Alene district purplish gray quartzites are mapped as St. Regis Formation, but that in Mineral County some distinctly purplish-gray quarzites are included in the Burke and Revett formations. The quartzites of the Burke and Revett formations are well exposed in road cuts along a 4 mile section of U.S. 10 immediately east of Saltese, Montana.

St. Regis Formation
See Figure 1B

West of the State line in Idaho, the St. Regis Formation is typically gray to purplish gray argillite, about 1200 to 1400 ft. thick, and has an upper member of thinly laminated greenish argillite, 150 to 450 ft. thick.

Half a mile southeast of Lookout Pass on U.S. 10, roadcuts expose interbedded greenish gray (5G6-7/1) and purplish gray (5P5-6/0.2) argillites or reddish gray (5R6/1) argillites and fine grained quartizites. Two miles further southeast of Lookout Pass, purplish gray colors are uncommon and are confined to the more quartzitic beds with the typical color being greenish gray. Near Randolph Creek, thinly laminated greenish gray argillites, typical of the upper member of the St. Regis Formation west of Lookout Pass, make up the major part of a stratigraphic section about 3,000 feet thick.

The St. Regis Formation in Montana, as mapped by Wallace and Hosterman, may include the adjoining parts of the formations both above and below it, as they have been mapped in the Coeur d'Alene District in Idaho.

The predominance of argillite was used as the principal criterion in distinguishing the St. Regis Formation, although quartzitic beds a foot or more thick can be found almost everywhere in the section. The contact between the St. Regis and the overlying Wallace Formation is defined by Wallace and Hosterman as being at the top of the predominately argillaceous series.

Wallace Formation
See Figure 1C

The top of the formation was not found in this area, so only a part of the formation is mapped. The most complete section found is at the head of Sarenac Creek and can be divided into the four units that follow:

Argillite, thinly laminated, laminae commonly from paper thin to 1/4 inch thick, contrasting dark and light-gray; many limy beds: 2,000± Feet

Argillite, phyllitic, bedding obscure, light olive gray: 1,500±

Argillite, thinly bedded, dark-gray, relatively homogenous:	500±
Argillite and limy quartzite, banded and interbedded, bands commonly from 1 inch to 2 inches thick, limy parts etched on weathered surfaces and stained brown:	2,500±
	6,500±

The transition zone from the St. Regis Formation to the Wallace is well shown at the mouth of Dominion Creek.

There are minor glacial deposits, glacial outwash deposits and some silts and gravels deposited in Glacial Lake Missoula, as well as valley fill and soil mantle. These are all mapped as one unit because to differentiate them and to map each separately would be very time consuming, and structurally speaking, they are essentially very similar.

This gives us four map units:

1. Burke and Revett quartzites
2. St. Regis argillite
3. Wallace argillite
4. Loose surface material: glacial drift, valley fill, bedded silts and gravels and soil mantle.

STRUCTURAL FEATURES

The area under study is underlain by a faulted homocline dipping south. The western part of this area is complicated by the Lookout Snycline and Lookout Anticline.

The major structural feature is the Osburn Fault Zone. In addition, there are numerous smaller faults that seem to be parallel or slightly diverging branches of the main Osburn Fault There is some evidence of some fault structures, striking approximately at right angles to the Osburn Fault; however, no large displacement stratigraphically could be demonstrated. Examination of several mining adits showed a great number of small fault movements, especially in the Revett and Burke quartzites. Regardless of the amount of displacement, the entire Osburn Fault Zone is composed of crushed and intensely bleached and altered quartzites and argillites.

Silver Creek Fault

A large fault crossing Silver Creek and extending westward to the Idaho line is called by Wallace and Hosterman "The Silver Creek Fault". It can be seen in the railroad cut near the southern portal of a tunnel on Dominion Creek, where it is a zone of crushed and sheared rocks more than 20 feet wide. From the Denna Mora Campground westward, there seems to be several fault strands and possibly an intersection with another large fault of slightly different strike. This diverging fault strand is marked by the saddle of St. Regis Pass and has been mapped in the mine workings on the Idaho side of the divide. Apparently the movement along the Silver Creek Fault is dissipated in several minor faults, the largest of which is marked by the saddle of Lookout Pass.

Minor Faulting

There are numerous small faults, a number of which strike slightly east of north and dip from steep to fairly low angles to the east. These can be seen in mine workings, but their presence is mostly postulated by the offsets in the main valley of the St. Regis River The largest structural evidence is where the sharp U bend in the St. Regis River occurs at the mouth of Hanaker and Brimstone Creeks The aerial photographs show a definite lineament on the west edge of both valleys curving to the west as the elevation increases. No outcrop could be found to either prove or disprove the existence of such a fault, but the structural control is convincing.

SOIL AND ROCK PROPERTIES

Map Unit QT is generally a fairly thin, 2.0 to 20.0 feet layer of soil, gravel or glacial moraine with a few spots showing some silt beds. In well drained areas back slopes of 1 1/2:1 will be satisfactory. No deep cuts in this material are anticipated.

The other three map units represent hard durable beds but badly fractured. The controlling factor is the strike and dip which are flatter than the general recommendations call for in only two places; the mouth of Randolph Creek and in the Osburn Fault Zone. Generally a 1 1/2:1 equivalent slope with benches to break the continuity of the slope will be satisfactory back slopes.

At the mouth of Randolph Creek, special recommendations are made for each line affected.

In the Osburn Fault Zone, due to the broken nature of the ground and the varying dips encountered, a general 2:1 equivalent backslope with benches will be necessary.

Lookout Syncline and Lookout Anticline

The Lookout Syncline is exposed in the cuts on U.S. 10 just east of Lookout Pass. It can be traced about 2 miles west and 3 miles east of Lookout Pass. It is almost parallel to the Lookout Anticline, an anticline overturned to the north, which is not exposed by U.S. 10 roadcuts.

To the east, both folds die out in the main homoclinal structure, which strikes generally northwest and dips southwest at near 45°.

Osburn Fault Zone
See Figure 1D

This fault zone has been traced continuously from Fernan Lake near Coeur d'Alene, Idaho, where its westward extension is covered by Columbia River basalt, eastward to the Nancy Lee mining district north of Superior, Montana. A large fault zone has been identified at several points along the eastward projection of this fault zone, the furthest eastward being near Missoula, Montana. The length of this fault zone therefore, is at least 90 miles, very probably 140 miles, and possibly over 250 miles, if a detailed study were to be made.

The fault zone is very well marked by erosion features, such as saddles and structurally controlled valleys, as it is more easily eroded than the formations on either side of it. It was a valley structure during the Pliestocene, as is shown by both glacial and lacastrine deposits found in the structural trough along its strike. The reason that the main drainage of the St. Regis River does not follow the Osburn Fault lies in the fact that it was probably covered by a large body of glacial ice, the outflow from which started carving the present valley of the St. Regis River, which lies from 2 to 3 miles south of the fault trough.

The fault zone at Mullan Pass appears to be a crushed or sheared zone nearly 1,000 feet wide. Where it crosses Packer Creek, it appears to consist of a north and south shear zone, each several hundred feet wide with an uncrushed block between. (Meadow Mountain).

Outcrops of the fault zone can be found at several points along the Randolph Creek Road, near the Silver Cable Mine, the Ben Hur Tunnel, the Wabash Mine and the Tarbox Mine, and in a cut on the west fork of Packer Creek Raod. The outcrop was mapped by connecting these identifiable points and using the "bleaching" effect and south facing escarpments as a guide to the location of the fault zone.

The displacement along the Osburn Fault is generally thought to be extensive. Some estimates being in the range of 15 to 20 miles. Wallace and Hosterman are of the opinion that there may be more complicated strike slip movements coupled with later overturned fold distortion and also some later faulting with relatively minor displacement.

FIG. 1 A
BURKE & REVETT
FORMATIONS

FIG. 1 B
ST. REGIS
FORMATION

FIG. 1 C
WALLACE FORMATION

FIG. 1 D
SHEAR ZONE 17
OSBURN FAULT ZONE

BACK SLOPE RECOMMENDATIONS

A-5 Line

1-1/2:1	Sta. 0+00 to Sta. 165+15
	Sta. 165+15 Bk A-5 Line =
	Sta. 169+05 Ah A-7 Line

A-7 Line

1-1/2:1	Sta. 0+00 to Sta. 534+50
1-3/4:1	Sta. 534+50 to Sta. 590+00

B-5 Line

2:1	Sta. 0+00 to Sta. 400+00
1-1/2:1	Sta. 400+0 to Sta. 427+70
	Sta. 427+70 B-5 Line Bk =
	Sta. 413+40 B-7 Line Ah

B-7 Line

2:1	Sta. 0+00 to Sta. 330+00
1-1/2:1	Sta. 330+00 to Sta. 447+00
	Sta. 447+00 B-7 Line Bk =
	Sta. 559+00 A-7 Line Ah

C-5 Line

2:1	Sta. 0+00 to Sta. 175+00
1-1/2:1	Sta. 175+00 to Sta. 295+00
2-1/4:1	Sta. 295+00 to Sta. 340+00
	Sta. 340+00 C-5 Line Bk =
	Sta. 360+00 A-7 Line Ah

C-7 Line

2:1	Sta. 0+00 to Sta. 170+00
1-1/2:1	Sta. 170+00 to Sta. 270+00
2-1/2:1	Sta. 270+00 to Sta. 316+20
	Sta. 316+20 C-7 Line Bk =
	Sta. 360+00 A-7 Line Ah

The backslopes listed are for shallow cuts. Where a deep cut is indicated benches should be used with steeper backslopes between the benches making the total slope equivalent to the backslope shown. For example, in a deep cut with 2-1/4:1 backslope a 25 foot berm on a 50 foot cut with 1-3/4:1 backslopes above and below the berm would give a 2-1/4:1 overall slope.

CONSTRUCTION DATA AND COSTS

Location surveys for the alternate routes were made by aerial methods. Through the use of photogrammetry and plotters, contour maps were prepared with 20 foot intervals. From these maps, cross sections were taken at 200 foot stations, and the data from these cross sections were processed through electronic computers to produce the earthwork quantities involved.

Other items were estimated on the basis of data obtained from the drainage and geologic reports, typical sections and other sources. Tables No. 3 to 11 show the estimated quantities involved for principal construction items, the agreed unit price of these items, the total construction cost, and the annual amortized construction cost based on the service lives shown on the tables.

It is emphasized that these tables are not complete for the tunnel routes for the reason that the construction costs for the tunnels are to be produced by Idaho personnel and will be included in the report for that state. It is also misleading to attempt to evaluate the worth of the various routes in Montana on the basis of these cost tables. In order to make a valid comparison, it is necessary to consider the costs for the entire route in both states.

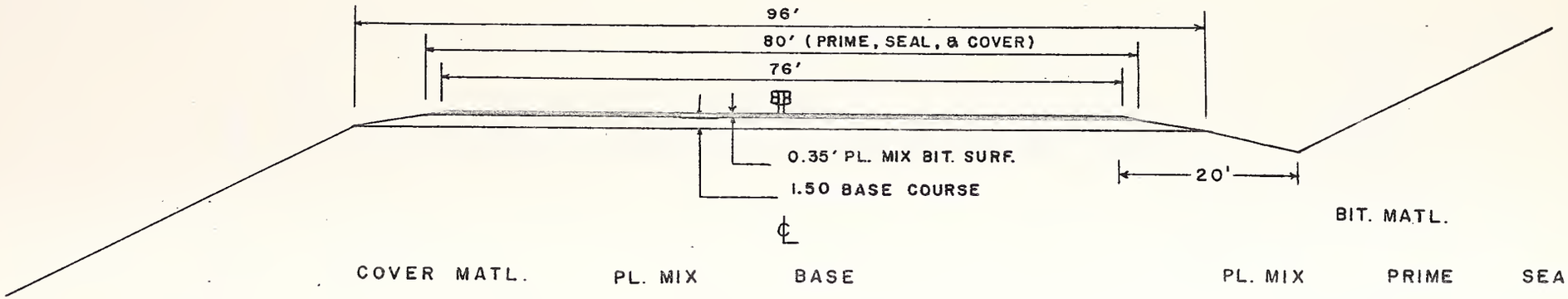
MAINTENANCE COSTS

As explained in the introduction, it was mutually agreed between the two states involved that maintenance costs would be established in the amount of $1,000 per mile per year for general maintenance and $2,500 per mile for such items as special maintenance, snow removal and sanding.

It was also agreed that Idaho personnel would produce an estimate of the cost of maintaining the entire length of the tunnels where they were involved. These costs are to be included in the Idaho report.

Table No. 16 shows the annual cost of maintenance of the Montana sections of the alternate routes, based on the product of the route length and the overall cost of $3,500 per mile per year.

TYPICAL SECTION
MULLAN — SALTESE
FOR COST STUDY ONLY



	COVER MATL.	PL. MIX	BASE		PL. MIX	BIT. MATL. PRIME	SEAL
AREA SQ. FT.		27.300	132.000				
CU. YDS. PER STA.		101.111	488.889	SQ. YD. PER STA.		888.889	888.889
TONS PER STA.	11.111	197.925	891.000	TONS PER STA.	10.886	1.133	1.133
TONS PER MILE	586.7	10,450.4	47,044.8	TONS PER MILE	574.8	59.8	59.8

INCLUDES WT. OF PL. MIX OIL (5.5 %)

PL. MIX	145 LBS. PER CU. FT.
BASE	135 LBS. PER CU. FT.
PRIME & SEAL	0.3 GAL. PER SQ. YD.
BIT. MATL.	8.5 LBS. PER GAL.
COVER	25 LBS. PER SQ. YD.

TABLE NO. 3

ESTIMATED CONSTRUCTION COSTS

ROUTE A-7 LOOKOUT PASS

CONSTRUCTION ITEM	UNIT	UNIT COST	NO. UNITS	TOTAL COST	ANNUAL AMORTIZED COST LIFE	RATE	AMOUNT
1. Clear and grub	Acre	$ 700.00	220	$ 154,000	40	.0505	$ 7,777
2. Uncl. excavation	Cu. yd.	.90	5,500,000	4,950,000	40	.0505	249,975
3. Overhaul	Mi. yd.	.20	3,100,000	620,000	40	.0505	31,310
4. Base	Ton	1.50	526,850	790,000	20	.0736	58,144
5. Prime	Ton	50.00	670	34,000	20	.0736	2,502
6. P. M. Oil	Ton	40.00	6,380	255,000	20	.0736	18,768
7. Plant mix	Ton	3.50	117,040	410,000	20	.0736	30,176
8. Seal	Ton	50.00	670	34,000	20	.0736	2,502
9. Cover	Ton	5.00	6,610	33,000	20	.0736	2,429
10. Pipe drain - 24"	Lin. ft.	10.00	2,478	25,000	40	.0505	1,262
11. Pipe drain - 36"	Lin. ft.	20.00	3,276	66,000	40	.0505	3,333
12. Pipe drain - 48"	Lin. ft.	25.00	836	21,000	40	.0505	1,060
13. Pipe drain - 60"	Lin. ft.	35.00			40	.0505	
14. Pipe drain - 72"	Lin. ft.	45.00			40	.0505	
15. Pipe drain - 84"	Lin. ft.	60.00	764	46,000	40	.0505	2,323
16. Pipe drain- 120"	Lin. ft.	85.00	736	63,000	40	.0505	3,182
17. Guard rail	Lin. ft.	3.00	66,400	199,000	20	.0736	14,646
18. Median rail	Lin. ft.	4.00	59,000	236,000	20	.0736	17,370
19. Fence-both sides	Mile	5,000.00	11.2	56,000	20	.0736	4,122
20. R.R. relocation	Lin. ft.	15.00	4,500	68,000	40	.0505	3,434
21. Structures	Lump sum			840,000	50	.0465	39,060
22. R/W and utilities	Lump sum			127,000	50	.0465	5,906
TOTAL - ALL ITEMS				$ 9,027,000			$ 499,281

TABLE NO. 4

ESTIMATED CONSTRUCTION COSTS

ROUTE A-5 LOOKOUT PASS

CONSTRUCTION ITEM	UNIT	UNIT COST	NO. UNITS	TOTAL COST	ANNUAL AMORTIZED COST LIFE	RATE	AMOUNT
1. Clear and grub	Acre	$ 700.00	300	$ 210,000	40	.0505	$ 10,605
2. Uncl. excavation	Cu. yd.	.90	9,600,000	8,640,000	40	.0505	436,320
3. Overhaul	Mi. yd.	.20	3,100,000	620,000	40	.0505	31,310
4. Base	Ton	1.50	522,140	783,000	20	.0736	57,629
5. Prime	Ton	50.00	670	34,000	20	.0736	2,502
6. P. M. Oil	Ton	40.00	6,330	253,000	20	.0736	18,621
7. Plant mix	Ton	3.50	116,000	406,000	20	.0736	29,882
8. Seal	Ton	50.00	670	34,000	20	.0736	2,502
9. Cover	Ton	5.00	6,550	33,000	20	.0736	2,429
10. Pipe drain - 24"	Lin. ft.	10.00	3,430	34,000	40	.0505	1,717
11. Pipe drain - 36"	Lin. ft.	20.00	3,250	65,000	40	.0505	3,282
12. Pipe drain - 48"	Lin. ft.	25.00	1,346	34,000	40	.0505	1,717
13. Pipe drain - 60"	Lin. ft.	35.00			40	.0505	
14. Pipe drain - 72"	Lin. ft.	45.00			40	.0505	
15. Pipe drain - 84"	Lin. ft.	60.00	1,096	66,000	40	.0505	3,333
16. Pipe drain- 120"	Lin. ft.	85.00	490	42,000	40	.0505	2,121
17. Guard rail	Lin. ft.	3.00	62,600	188,000	20	.0736	13,837
18. Median rail	Lin. ft.	4.00	58,610	234,000	20	.0736	17,222
19. Fence-both sides	Mile	5,000.00	11.1	56,000	20	.0736	4,122
20. R.R. relocation	Lin. ft.	15.00	4,500	68,000	40	.0505	3,434
21. Structures	Lump sum			1,050,000	50	.0465	48,825
22. R/W and utilities	Lump sum			127,000	50	.0465	5,906
TOTAL - ALL ITEMS				$12,977,000			$ 697,316

TABLE NO. 5

ESTIMATED CONSTRUCTION COSTS

ROUTE B-7 PACKER CREEK

CONSTRUCTION ITEM	UNIT	UNIT COST	NO. UNITS	TOTAL COST	ANNUAL AMORTIZED COST LIFE	RATE	AMOUNT
1. Clear and grub	Acre	$ 700.00	350	$ 245,000	40	.0505	$ 12,372
2. Uncl. excavation	Cu. yd.	.90	8,700,000	7,830,000	40	.0505	395,415
3. Overhaul	Mi. yd.	.20	1,500,000	300,000	40	.0505	15,150
4. Base	Ton	1.50	423,360	635,000	20	.0736	46,736
5. Prime	Ton	50.00	540	27,000	20	.0736	1,987
6. P. M. Oil	Ton	40.00	5,130	205,000	20	.0736	15,088
7. Plant mix	Ton	3.50	94,050	329,000	20	.0736	24,214
8. Seal	Ton	50.00	540	27,000	20	.0736	1,987
9. Cover	Ton	5.00	5,310	27,000	20	.0736	1,987
10. Pipe drain - 24"	Lin. ft.	10.00	1,110	11,000	40	.0505	556
11. Pipe drain - 36"	Lin. ft.	20.00	4,590	92,000	40	.0505	4,646
12. Pipe drain - 48"	Lin. ft.	25.00	1,940	48,000	40	.0505	2,424
13. Pipe drain - 60"	Lin. ft.	35.00	518	18,000	40	.0505	909
14. Pipe drain - 72"	Lin. ft.	45.00	438	20,000	40	.0505	1,010
15. Pipe drain - 84"	Lin. ft.	60.00			40	.0505	
16. Pipe drain- 120"	Lin. ft.	85.00	510	43,000	40	.0505	2,172
17. Guard rail	Lin. ft.	3.00	35,600	107,000	20	.0736	7,875
18. Median rail	Lin. ft.	4.00	47,680	191,000	20	.0736	14,058
19. Fence-both sides	Mile	5,000.00	9.0	45,000	20	.0736	3,312
20. R.R. relocation	Lin. ft.	15.00			40	.0505	
21. Structures	Lump sum			100,000	50	.0465	4,650
22. R/W and utilities	Lump sum			17,000	50	.0465	790
TOTAL - ALL ITEMS				$10,317,000			$ 557,338

TABLE NO. 6

ESTIMATED CONSTRUCTION COSTS

ROUTE B-5 PACKER CREEK

CONSTRUCTION ITEM	UNIT	UNIT COST	NO. UNITS	TOTAL COST	ANNUAL AMORTIZED COST LIFE	RATE	AMOUNT
1. Clear and grub	Acre	$ 700.00	480	$ 336,000	40	.0505	$ 16,968
2. Uncl. excavation	Cu. yd.	.90	17,500,000	15,750,000	40	.0505	795,375
3. Overhaul	Mi. yd.	.20	7,000,000	1,400,000	40	.0505	70,700
4. Base	Ton	1.50	437,470	656,000	20	.0736	48,282
5. Prime	Ton	50.00	560	28,000	20	.0736	2,061
6. P. M. Oil	Ton	40.00	5,300	212,000	20	.0736	15,603
7. Plant mix	Ton	3.50	97,180	340,000	20	.0736	25,024
8. Seal	Ton	50.00	560	28,000	20	.0736	2,061
9. Cover	Ton	5.00	5,490	27,000	20	.0736	1,987
10. Pipe drain - 24"	Lin. ft.	10.00	3,790	38,000	40	.0505	1,919
11. Pipe drain - 36"	Lin. ft.	20.00	4,052	81,000	40	.0505	4,090
12. Pipe drain - 48"	Lin. ft.	25.00	2,170	54,000	40	.0505	2,727
13. Pipe drain - 60"	Lin. ft.	35.00	904	32,000	40	.0505	1,616
14. Pipe drain - 72"	Lin. ft.	45.00			40	.0505	
15. Pipe drain - 84"	Lin. ft.	60.00	440	26,000	40	.0505	1,313
16. Pipe drain- 120"	Lin. ft.	85.00			40	.0505	
17. Guard rail	Lin. ft.	3.00	42,800	128,000	20	.0736	9,421
18. Median rail	Lin. ft.	4.00	49,110	196,000	20	.0736	14,426
19. Fence-both sides	Mile	5,000.00	9.3	46,000	20	.0736	3,386
20. R.R. relocation	Lin. ft.	15.00			40	.0505	
21. Structures	Lump sum			100,000	50	.0465	4,650
22. R/W and utilities	Lump sum			17,000	50	.0465	790
TOTAL - ALL ITEMS				$19,495,000			$1,022,399

TABLE NO. 7

ESTIMATED CONSTRUCTION COSTS

ROUTE C-7 RANDOLPH CREEK

CONSTRUCTION ITEM	UNIT	UNIT COST	NO. UNITS	TOTAL COST	ANNUAL AMORTIZED COST LIFE	RATE	AMOUNT
1. Clear and grub	Acre	$ 700.00	380	$ 266,000	40	.0505	$ 13,433
2. Uncl. excavation	Cu. yd.	.90	8,200,000	7,380,000	40	.0505	372,690
3. Overhaul	Mi. yd.	.20	2,900,000	580,000	40	.0505	29,290
4. Base	Ton	1.50	489,220	734,000	20	.0736	54,022
5. Prime	Ton	50.00	620	31,000	20	.0736	2,282
6. P. M. Oil	Ton	40.00	5,930	237,000	20	.0736	17,443
7. Plant mix	Ton	3.50	108,680	380,000	20	.0736	27,968
8. Seal	Ton	50.00	620	31,000	20	.0736	2,282
9. Cover	Ton	5.00	6,140	31,000	20	.0736	2,282
10. Pipe drain - 24"	Lin. ft.	10.00	2,234	22,000	40	.0505	1,111
11. Pipe drain - 36"	Lin. ft.	20.00	3,480	70,000	40	.0505	3,535
12. Pipe drain - 48"	Lin. ft.	25.00	1,940	48,000	40	.0505	2,424
13. Pipe drain - 60"	Lin. ft.	35.00			40	.0505	
14. Pipe drain - 72"	Lin. ft.	45.00	320	14,000	40	.0505	707
15. Pipe drain - 84"	Lin. ft.	60.00	830	50,000	40	.0505	2,525
16. Pipe drain- 120"	Lin. ft.	85.00			40	.0505	
17. Guard rail	Lin. ft.	3.00	53,000	159,000	20	.0736	11,702
18. Median rail	Lin. ft.	4.00	54,660	219,000	20	.0736	16,118
19. Fence-both sides	Mile	5,000.00	10.4	52,000	20	.0736	3,827
20. R.R. relocation	Lin. ft.	15.00	4,500	68,000	40	.0505	3,434
21. Structures	Lump sum			460,000	50	.0465	21,390
22. R/W and utilities	Lump sum			83,000	50	.0465	3,860
TOTAL - ALL ITEMS				$10,915,000			$ 592,325

TABLE NO. 8

ESTIMATED CONSTRUCTION COSTS

ROUTE C-5 RANDOLPH CREEK

CONSTRUCTION ITEM	UNIT	UNIT COST	NO. UNITS	TOTAL COST	ANNUAL AMORTIZED COST LIFE	RATE	AMOUNT
1. Clear and grub	Acre	$ 700.00	430	$ 301,000	40	.0505	$ 15,200
2. Uncl. excavation	Cu. yd.	.90	11,100,000	9,990,000	40	.0505	504,495
3. Overhaul	Mi. yd.	.20	7,700,000	1,540,000	40	.0505	77,770
4. Base	Ton	1.50	508,030	762,000	20	.0736	56,083
5. Prime	Ton	50.00	650	32,000	20	.0736	2,355
6. P. M. Oil	Ton	40.00	6,160	246,000	20	.0736	18,106
7. Plant mix	Ton	3.50	112,860	395,000	20	.0736	29,072
8. Seal	Ton	50.00	650	32,000	20	.0736	2,355
9. Cover	Ton	5.00	6,370	32,000	20	.0736	2,355
10. Pipe drain - 24"	Lin. ft.	10.00	1,770	18,000	40	.0505	909
11. Pipe drain - 36"	Lin. ft.	20.00	5,126	103,000	40	.0505	5,202
12. Pipe drain - 48"	Lin. ft.	25.00	2,310	58,000	40	.0505	2,929
13. Pipe drain - 60"	Lin. ft.	35.00			40	.0505	
14. Pipe drain - 72"	Lin. ft.	45.00			40	.0505	
15. Pipe drain - 84"	Lin. ft.	60.00	218	13,000	40	.0505	656
16. Pipe drain- 120"	Lin. ft.	85.00			40	.0505	
17. Guard rail	Lin. ft.	3.00	53,600	161,000	20	.0736	11,850
18. Median rail	Lin. ft.	4.00	57,040	228,000	20	.0736	16,781
19. Fence-both sides	Mile	5,000.00	10.8	54,000	20	.0736	3,974
20. R.R. relocation	Lin. ft.	15.00	4,500	68,000	40	.0505	3,434
21. Structures	Lump sum			460,000	50	.0465	21,390
22. R/W and utilities	Lump sum			83,000	50	.0465	3,860
TOTAL - ALL ITEMS				$14,576,000			$ 778,776

TABLE NO. 9

ESTIMATED CONSTRUCTION COSTS

ROUTE D ST. REGIS TUNNEL

CONSTRUCTION ITEM	UNIT	UNIT COST	NO. UNITS	TOTAL COST	ANNUAL AMORTIZED COST LIFE	RATE	AMOUNT
1. Clear and grub	Acre	$ 700.00	190	$ 133,000	40	.0505	$ 6,716
2. Uncl. excavation	Cu. yd.	.90	5,300,000	4,770,000	40	.0505	240,885
3. Overhaul	Mi. yd.	.20	2,700,000	540,000	40	.0505	27,270
4. Base	Ton	1.50	517,440	776,000	20	.0736	57,114
5. Prime	Ton	50.00	660	33,000	20	.0736	2,429
6. P. M. Oil	Ton	40.00	6,270	251,000	20	.0736	18,474
7. Plant mix	Ton	3.50	114,950	402,000	20	.0736	29,587
8. Seal	Ton	50.00	660	33,000	20	.0736	2,429
9. Cover	Ton	5.00	6,490	32,000	20	.0736	2,355
10. Pipe drain - 24"	Lin. ft.	10.00	2,212	22,000	40	.0505	1,111
11. Pipe drain - 36"	Lin. ft.	20.00	2,912	58,000	40	.0505	2,929
12. Pipe drain - 48"	Lin. ft.	25.00	998	25,000	40	.0505	1,262
13. Pipe drain - 60"	Lin. ft.	35.00			40	.0505	
14. Pipe drain - 72"	Lin. ft.	45.00			40	.0505	
15. Pipe drain - 84"	Lin. ft.	60.00	764	46,000	40	.0505	2,323
16. Pipe drain- 120"	Lin. ft.	85.00	736	63,000	40	.0505	3,182
17. Guard rail	Lin. ft.	3.00	64,800	194,000	20	.0736	14,278
18. Median rail	Lin. ft.	4.00	58,280	233,000	20	.0736	17,149
19. Fence-both sides	Mile	5,000.00	11.0	55,000	20	.0736	4,048
20. R.R. relocation	Lin. ft.	15.00	4,500	68,000	40	.0505	3,434
21. Structures	Lump sum			840,000	50	.0465	39,060
22. R/W and utilities	Lump sum			127,000	50	.0465	5,906
TOTAL - ALL ITEMS				$ 8,701,000			$ 481,941

TABLE NO. 10

ESTIMATED CONSTRUCTION COSTS

ROUTE E LOOKOUT TUNNEL

CONSTRUCTION ITEM	UNIT	UNIT COST	NO. UNITS	TOTAL COST	ANNUAL AMORTIZED COST LIFE	RATE	AMOUNT
1. Clear and grub	Acre	$ 700.00	210	$ 147,000	40	.0505	$ 7,424
2. Uncl. excavation	Cu. yd.	.90	5,500,000	4,950,000	40	.0505	249,975
3. Overhaul	Mi. yd.	.20	4,300,000	860,000	40	.0505	43,430
4. Base	Ton	1.50	517,440	776,000	20	.0736	57,114
5. Prime	Ton	50.00	660	33,000	20	.0736	2,429
6. P. M. Oil	Ton	40.00	6,270	251,000	20	.0736	18,474
7. Plant mix	Ton	3.50	114,950	402,000	20	.0736	29,587
8. Seal	Ton	50.00	660	33,000	20	.0736	2,429
9. Cover	Ton	5.00	6,490	32,000	20	.0736	2,355
10. Pipe drain - 24"	Lin. ft.	10.00	2,226	22,000	40	.0505	1,111
11. Pipe drain - 36"	Lin. ft.	20.00	2,916	58,000	40	.0505	2,929
12. Pipe drain - 48"	Lin. ft.	25.00	1,040	26,000	40	.0505	1,313
13. Pipe drain - 60"	Lin. ft.	35.00			40	.0505	
14. Pipe drain - 72"	Lin. ft.	45.00			40	.0505	
15. Pipe drain - 84"	Lin. ft.	60.00	764	46,000	40	.0505	2,323
16. Pipe drain- 120"	Lin. ft.	85.00	728	62,000	40	.0505	3,131
17. Guard rail	Lin. ft.	3.00	63,600	191,000	20	.0736	14,058
18. Median rail	Lin. ft.	4.00	58,175	233,000	20	.0736	17,149
19. Fence-both sides	Mile	5,000.00	11.0	55,000	20	.0736	4,048
20. R.R. relocation	Lin. ft.	15.00	4,500	68,000	40	.0505	3,434
21. Structures	Lump sum			840,000	50	.0465	39,060
22. R/W and utilities	Lump sum			127,000	50	.0465	5,906
TOTAL - ALL ITEMS				$ 9,212,000			$ 507,679

TABLE NO. 11

ESTIMATED CONSTRUCTION COSTS

ROUTE F MULLAN TUNNEL

CONSTRUCTION ITEM	UNIT	UNIT COST	NO. UNITS	TOTAL COST	ANNUAL AMORTIZED COST LIFE	RATE	AMOUNT
1. Clear and grub	Acre	$ 700.00	330	$ 231,000	40	.0505	$ 11,666
2. Uncl. excavation	Cu. yd.	.90	8,600,000	7,740,000	40	.0505	390,870
3. Overhaul	Mi. yd.	.20	2,400,000	480,000	40	.0505	24,240
4. Base	Ton	1.50	409,250	614,000	20	.0736	45,190
5. Prime	Ton	50.00	520	26,000	20	.0736	1,914
6. P. M. Oil	Ton	40.00	4,960	198,000	20	.0736	14,573
7. Plant mix	Ton	3.50	90,920	318,000	20	.0736	23,405
8. Seal	Ton	50.00	520	26,000	20	.0736	1,914
9. Cover	Ton	5.00	5,130	26,000	20	.0736	1,914
10. Pipe drain - 24"	Lin. ft.	10.00	1,110	11,000	40	.0505	556
11. Pipe drain - 36"	Lin. ft.	20.00	4,480	90,000	40	.0505	4,545
12. Pipe drain - 48"	Lin. ft.	25.00	1,908	48,000	40	.0505	2,424
13. Pipe drain - 60"	Lin. ft.	35.00	518	18,000	40	.0505	909
14. Pipe drain - 72"	Lin. ft.	45.00	438	20,000	40	.0505	1,010
15. Pipe drain - 84"	Lin. ft.	60.00			40	.0505	
16. Pipe drain- 120"	Lin. ft.	85.00	510	43,000	40	.0505	2,172
17. Guard rail	Lin. ft.	3.00	34,200	103,000	20	.0736	7,581
18. Median rail	Lin. ft.	4.00	46,170	185,000	20	.0736	13,616
19. Fence-both sides	Mile	5,000.00	8.7	44,000	20	.0736	3,238
20. R.R. relocation	Lin. ft.	15.00			40	.0505	
21. Structures	Lump sum			100,000	50	.0465	4,650
22. R/W and utilities	Lump sum			17,000	50	.0465	790
TOTAL - ALL ITEMS				$10,338,000			$ 557,177

TRAFFIC SERVICE

Highway-user benefit analyses generally involve a comprehensive review of the service to different types of traffic which will be provided by each of the alternate routes. Consideration is given to the traffic service to local residents and communities along the highway and also to the through traffic which moves between principal points without stopping.

There generally is a conflict of interest for the reason that the through traffic ordinarily receives the greatest benefit from the shortest route between termini whereas local traffic is served best by a highway that is located in close proximity to the local development. A compromise must be reached in selecting the route which provides the greatest benefit from the standpoint of overall traffic.

Traffic analysis and assignment does not present a problem in this instance for the reason that the traffic involved consists almost entirely of through movement. There is a small amount of local traffic service involved along each of the alternate routes, with the greatest service being to development associated with the present highway. The amount of local traffic service is insignificant, however, and it has been disregarded as being irrelevant to the analysis.

It has been decided, by mutual agreement, that the traffic involved would be confined to the volume previously agreed upon by both states and reported in the Section 104 (b) 5 Study for submittal to Congress. This report showed that the 1958 traffic amounted to 1,490 vehicles per day on both sides of the border. It has been estimated that this traffic will increase to 3,500 vehicles per day by 1975, consisting of 90% passenger cars and 10% trucks and busses. Since small, two-axles trucks have the same operating characteristics as passenger cars, these vehicles are included with passenger cars, making the final division 94% passenger cars and 6% trucks and busses.

Traffic service is evaluated in monetary terms by computing the cost of vehicle operation for each of the alternate routes as determined by the length of each route and the variable operating conditions encountered on each route.

VEHICLE OPERATING COSTS

In most highway-user benefit analyses, gradient and curvature are of minor importance in computing vehicle operating costs. In this instance, however, both gradient and curvature are important because of the mountainous terrain through which the alternate routes must be located.

After conferring on the problem, it was evident that there was a lack of comprehensive data on truck operating costs as affected by various grades. It was decided that it was desirable to develop special data of this type for application to this analysis. It was agreed that passenger car operating costs, as reported in an AASHO publication, were suitable for this analysis, with the exception that it would be necessary to refine the data to fit smaller increments of grade than the broad categories reported in the AASHO report.

By mutual agreement, it was also decided that the truck operating costs would be computed by Idaho personnel and the passenger car operating costs would be computed by Montana personnel.

A review of the basic data, from which AASHO passenger car operating costs were developed, disclosed that fuel consumption increased with steepness of grade; however, the steepness of grade also reduced the travel speed with the result that fuel consumption was decreased by this feature. In combining these factors, it was found that there was a small increase in fuel consumption with increased grades. The price of 40¢ per gallon was used in computing the cost of fuel consumption.

There was also an increase in tire wear on grades, but this also was offset by a decrease in oil consumption through reduced speed. Reduced speed also increased the travel time. Maintenance, repairs and depreciation were found to be unaffected by grades.

Table No. 12 shows the passenger car operating costs as developed for increasing increments of grade. The value of time was estimated at $1.55 per hour.

In computing the truck operating costs, as adjusted for grade, reference was made to Highway Research Board Reports 9-A and 276. These reports provided the foundation material for truck operating costs on various grades. The basic data from these reports were used in computing fuel consumption for various types of vehicles, with prices of 40¢ per gallon for gasoline and 28¢ per gallon for diesel fuel.

The costs for maintenance, repairs, depreciation, oil and tires for trucks were estimated at 4 times the values shown for passenger cars in the AASHO report on this subject. The value of time was estimated at $3.00 per hour.

The costs for various types of trucks and combinations were consolidated to conform to the actual operating conditions found on Idaho highways in various surveys. These costs are shown in Table No. 13. This table also shows the combined costs per vehicle mile of travel on the part of both passenger cars and trucks, as adjusted for grade and applied to the same traffic on all alternate routes. Where fractional grades are involved, costs have been interpolated.

Horizontal curvature is also involved on the alternate locations to the extent that the vehicle operating costs would be affected. The

following shows the ratios which were used in compensating for curvature:

Curvature Deg.	Min.	Ratio	Curvature Deg.	Min.	Ratio
0	00	1.00	4	30	1.09
1	00	1.00	5	00	1.10
1	30	1.00	5	30	1.12
2	00	1.00	6	00	1.14
2	30	1.00	6	30	1.16
3	00	1.00	7	00	1.20
3	30	1.00	7	30	1.25
4	00	1.08			

Table No. 14 shows the final unit cost for operation of both cars and trucks with adjustment being made for gradient and curvature applying to each of the alternate routes.

TABLE NO. 12

ESTIMATED PASSENGER CAR OPERATING COSTS

(Based on Free Operation on 4-Lane Divided Highways)

Percent Grade	Operating Ratio	Operating Speed	Gallons Per Mile	Cost at 40¢	Tires	Oil	Mtce. & Repairs	Depreciation	Subtotal Oper. Costs	Time	Total
0	100	60	.0842	3.37	0.56	0.52	1.20	1.50	7.15	2.58	9.73
1	98	59	.0843	3.37	0.56	0.47	1.20	1.50	7.10	2.63	9.73
2	97	58	.0844	3.38	0.56	0.42	1.20	1.50	7.06	2.67	9.73
3	95	57	.0846	3.38	0.58	0.37	1.20	1.50	7.03	2.72	9.75
4	93	55	.0848	3.39	0.61	0.33	1.20	1.50	7.03	2.82	9.85
5	89	53	.0850	3.40	0.65	0.29	1.20	1.50	7.04	2.92	9.96
6	85	51	.0853	3.41	0.70	0.25	1.20	1.50	7.06	3.04	10.10
7	81	48	.0856	3.42	0.76	0.22	1.20	1.50	7.10	3.23	10.33

Remarks: Operating cost figures shown represent cents per vehicle-mile of travel.

TABLE NO. 13

COMBINED PASSENGER AND TRUCK OPERATING COSTS

(Based on Free Operation on 4-Lane Divided Highways)

Percent Grade	PASSENGER CAR - 94%				TRUCKS - 6%				ALL VEHICLES - 100%		
	Speed	Operating	Time	Total	Speed	Operating	Time	Total	Operating	Time	Total
0	60	7.15	2.58	9.73	50	20.95	6.00	26.95	7.98	2.79	10.77
1	59	7.10	2.63	9.73	47	20.02	6.38	26.40	7.88	2.86	10.74
2	58	7.06	2.67	9.73	42	19.94	7.14	27.08	7.83	2.94	10.77
3	57	7.03	2.72	9.75	35	21.17	8.57	29.74	7.88	3.07	10.95
4	55	7.03	2.82	9.85	28	22.90	10.71	33.61	7.98	3.29	11.27
5	53	7.04	2.92	9.96	22	24.84	13.64	38.48	8.11	3.56	11.67
6	51	7.06	3.04	10.10	19	26.62	15.79	42.41	8.23	3.81	12.04
7	48	7.10	3.23	10.33	18	28.39	17.33	45.72	8.38	4.07	12.45

Remarks: Passenger cars include panels, pickups and other light trucks.

Trucks include busses.

Operating cost figures shown represent cents per vehicle-mile of travel. The figures for ALL VEHICLES are weighted averages of passenger car and truck costs.

TABLE NO. 14

BASIC DATA FOR COMPUTING UNIT VEHICLE OPERATING COSTS

LINE	LOCATION	LENGTH	MAXIMUM GRADE	AVERAGE GRADIENT	MAXIMUM CURVE	AVERAGE CURVATURE	OPERATING COSTS PER VEHICLE-MILE		
							Based on Grades *	Adjustment For Curvature	Final Adjusted Figure
A-7	Lookout Pass	11.174	6.5	2.44	5-00	1-24	$.1104	1.0125	$.11178
A-5	Lookout Pass	11.100	5.0	2.44	5-00	1-24	.1104	1.0100	.11150
B-7	Packer Creek	9.030	7.0	3.91	6-00	1-26	.1137	1.0082	.11463
B-5	Packer Creek	9.301	5.0	3.79	7-30	1-37	.1129	1.0210	.11527
C-7	Randolph Creek	10.352	7.0	3.43	7-00	1-22	.1129	1.0093	.11395
C-5	Randolph Creek	10.803	5.0	3.29	7-00	1-43	.1123	1.0216	.11473
D	St. Regis Tunnel	11.038	5.0	2.03	5-00	1-27	.1089	1.0149	.11052
E	Lookout Tunnel	11.018	5.4	2.26	5-00	1-21	.1098	1.0112	.11103
F	Mullan Tunnel	8.744	7.0	3.86	6-00	1-21	.1136	1.0074	.11444

Remarks: * Basic figures range from $.1077 per vehicle mile for level section to $.1245 for 7.0 grade, with computations representing weighted averages for length of grades of various types. The figures represent weighted averages of passenger car and truck operating costs based on a distribution of 94% cars and 6% trucks as estimated 1975 traffic used in Sec. 104(b) 5 Study.

Average gradient and average curvature figures have been computed for the entire length of the route - not just for sections having curvature.

TABLE NO. 15

ESTIMATED ANNUAL VEHICLE OPERATING COSTS

LINE	LOCATION	LENGTH	ESTIMATED ADT-1975	ANNUAL VM OF TRAVEL	COST PER VEH. MILE	ANNUAL VEHICLE OPERATING COSTS
A-7	Lookout Pass	11.174	3,500	14,274,785	$ .11178	$ 1,595,635
A-5	Lookout Pass	11.100	"	14,180,250	.11150	1,581,098
B-7	Packer Creek	9.030	"	11,535,825	.11463	1,322,352
B-5	Packer Creek	9.301	"	11,882,028	.11527	1,369,641
C-7	Randolph Creek	10.352	"	13,224,680	.11395	1,506,952
C-5	Randolph Creek	10.803	"	13,800,833	.11473	1,583,370
D	St. Regis Tunnel	11.038	"	14,101,045	.11052	1,558,447
E	Lookout Tunnel	11.018	"	14,075,495	.11103	1,562,802
F	Mullan Tunnel	8.744	"	11,170,460	.11444	1,278,347

The total cost for vehicle operation over each of the alternate routes is shown in Table No. 15. This represents the estimated annual cost to the highway user in traveling over each of the routes between Saltese and the Montana-Idaho border.

It may be noted that, from the standpoint of vehicle operating costs only, the Mullan Tunnel Route would have the most favorable rating insofar as travel in Montana is concerned. Both routes up Packer Creek would have the next best rating. These routes are accorded this position because of their shorter lengths, but it should be explained that this advantage in Montana would be offset by longer lengths on the connecting routes in Idaho.

SUMMARY

Table No. 16 presents a summary of the combined annual cost for construction, maintenance and vehicle operation for each of the alternate routes. When these data are combined with similar data from the Idaho report, it will be possible to determine which route between Saltese and Mullan has the most favorable overall rating from an economic standpoint. The combination of data for the two states will be contained in a separate summary report which will be prepared at a later date after publication and analysis of the main reports for each state.

TABLE NO. 16

COMPARISON OF ANNUAL CONSTRUCTION

MAINTENANCE AND VEHICLE OPERATING COSTS

LINE	LOCATION	LENGTH	TOTAL COST OF CONSTRUCTION	ANNUAL COST OF CONSTRUCTION	ANNUAL COST OF MAINTENANCE AT $3,500/MILE	ANNUAL COST OF VEHICLE OPERATION	ANNUAL COST OF ALL COSTS
A-7	Lookout Pass	11.174	$ 9,027,000	$ 499,281	$39,109	$1,595,635	$2,134,025
A-5	Lookout Pass	11.100	12,977,000	697,316	38,850	1,581,098	2,317,264
B-7	Packer Creek	9.030	10,317,000	557,338	31,605	1,322,352	1,911,295
B-5	Packer Creek	9.301	19,495,000	1,022,399	32,554	1,369,641	2,424,594
C-7	Randolph Creek	10.352	10,915,000	592,325	36,232	1,506,952	2,135,509
C-5	Randolph Creek	10.803	14,576,000	778,776	37,811	1,583,370	2,399,957
D	St. Regis Tunnel	11.038	8,701,000	481,941	38,633	1,558,447	2,079,021
E	Lookout Tunnel	11.018	9,212,000	507,679	38,563	1,562,802	2,109,044
F	Mullan Tunnel	8.744	10,338,000	557,177	39,970	1,278,347	1,875,494

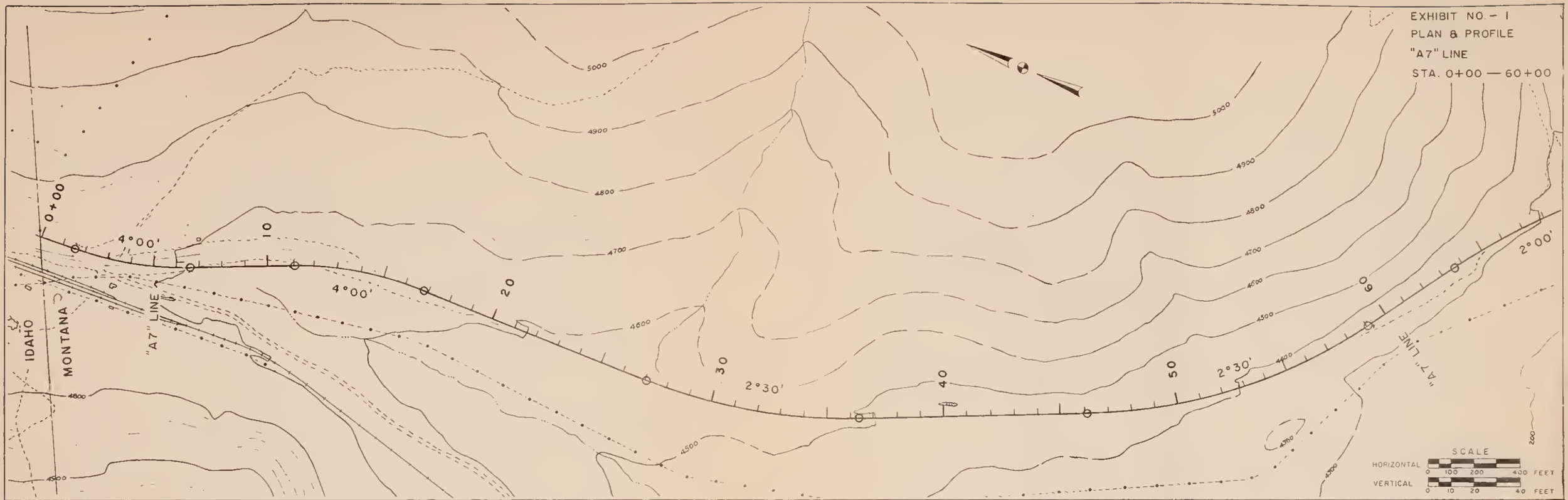
EXHIBITS 1 TO 10

ROUTE A-7

LOOKOUT PASS SURFACE ROUTE

GRADES NOT OVER 6.5 %
CURVES NOT OVER 5°00'
TOTAL LENGTH 11.174 MILES

EXHIBIT NO. - 1
PLAN & PROFILE
"A7" LINE
STA. 0+00 — 60+00



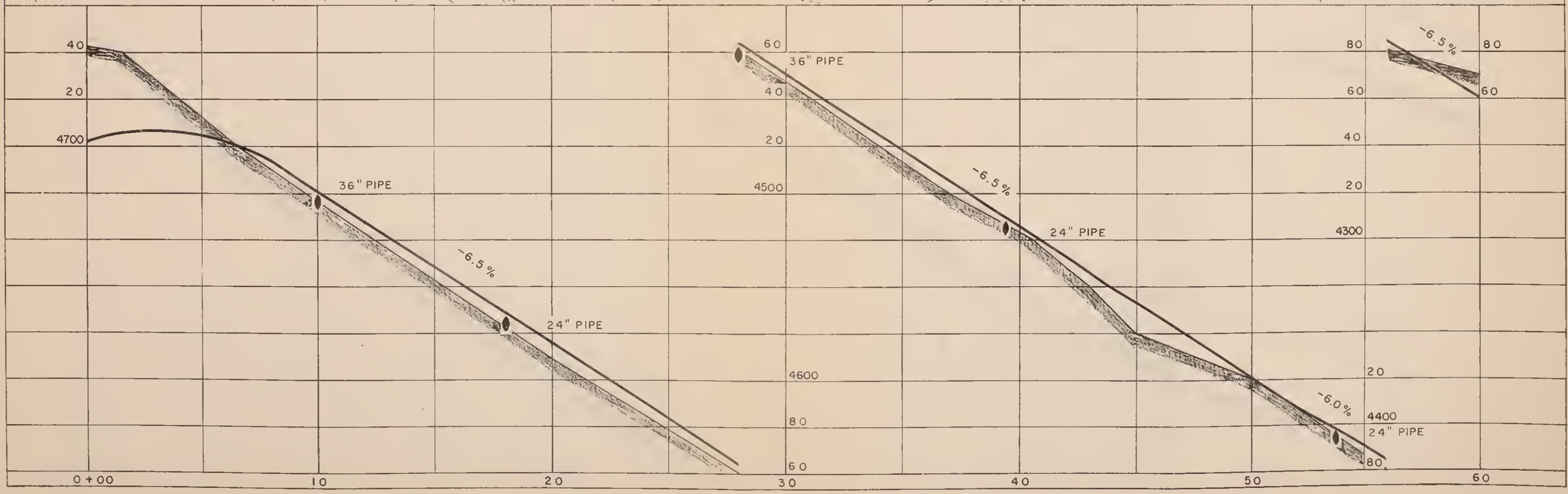


EXHIBIT NO.- 2
PLAN & PROFILE
"A7" LINE
STA. 60+00 — 120+00

"A7" LINE

1°30'

4°00'

SCALE
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VERTICAL 0 10 20 40 FEET

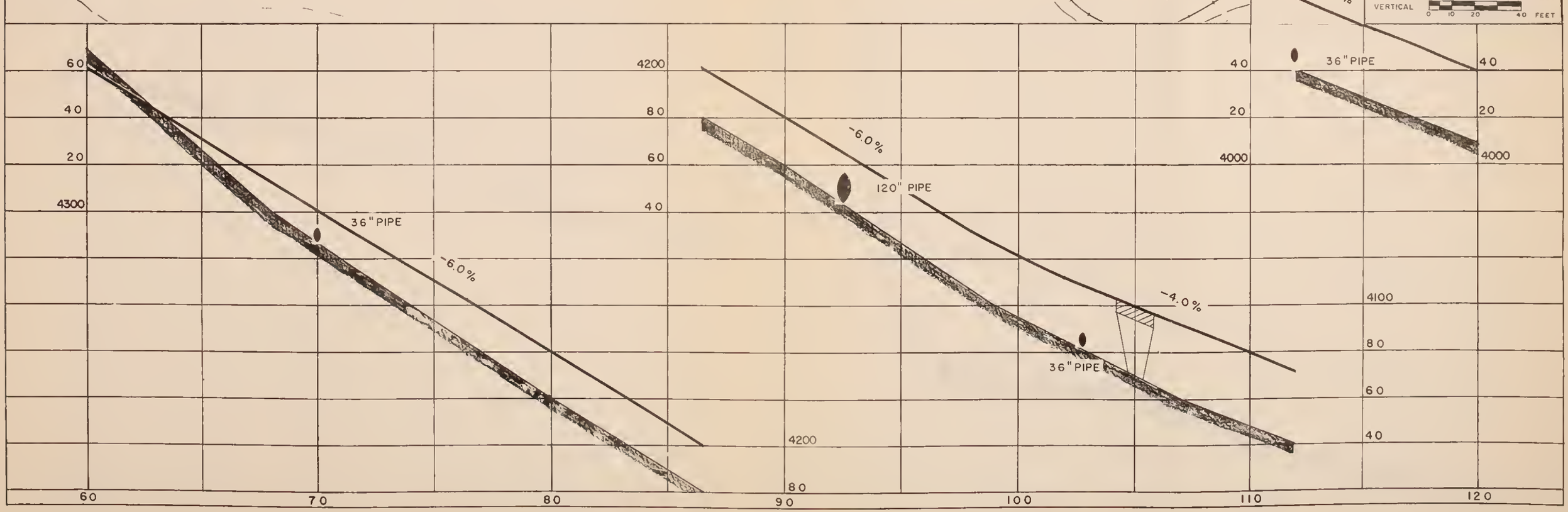


EXHIBIT NO. — 3

PLAN & PROFILE

"A 7" LINE

STA. 120+00 — 180+00

EXHIBIT NO. — 4
PLAN & PROFILE
"A7" LINE
STA. 180+00 — 240+00

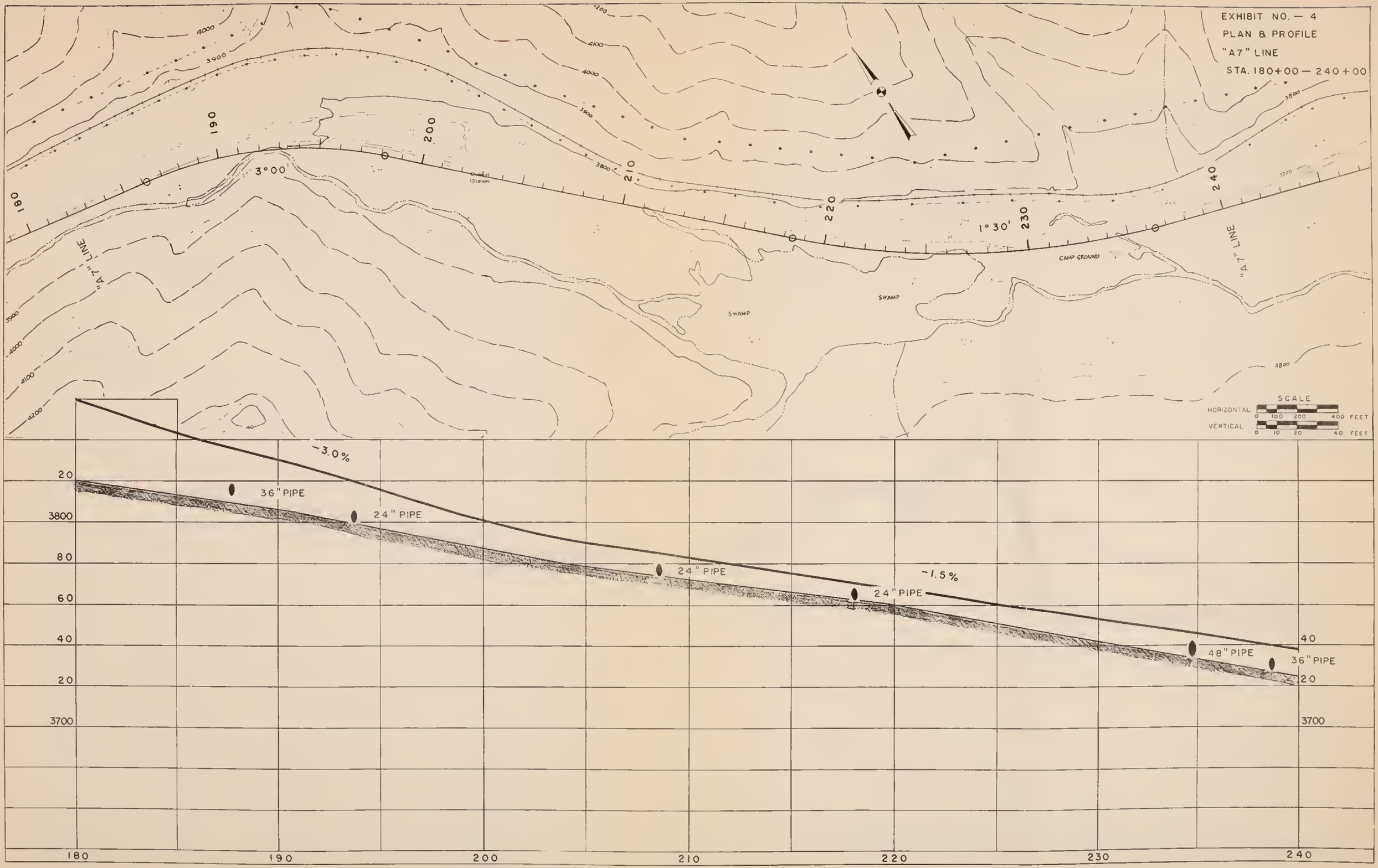


EXHIBIT NO. — 5
PLAN & PROFILE
"A7" LINE
STA 240 + 00 — 300 + 00

"A7" LINE

240 250 260 270 280 290 300

4°00' 3°30'

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

0.0 %

36" PIPE

36" PIPE

48" PIPE

-3.0 %

24" PIPE

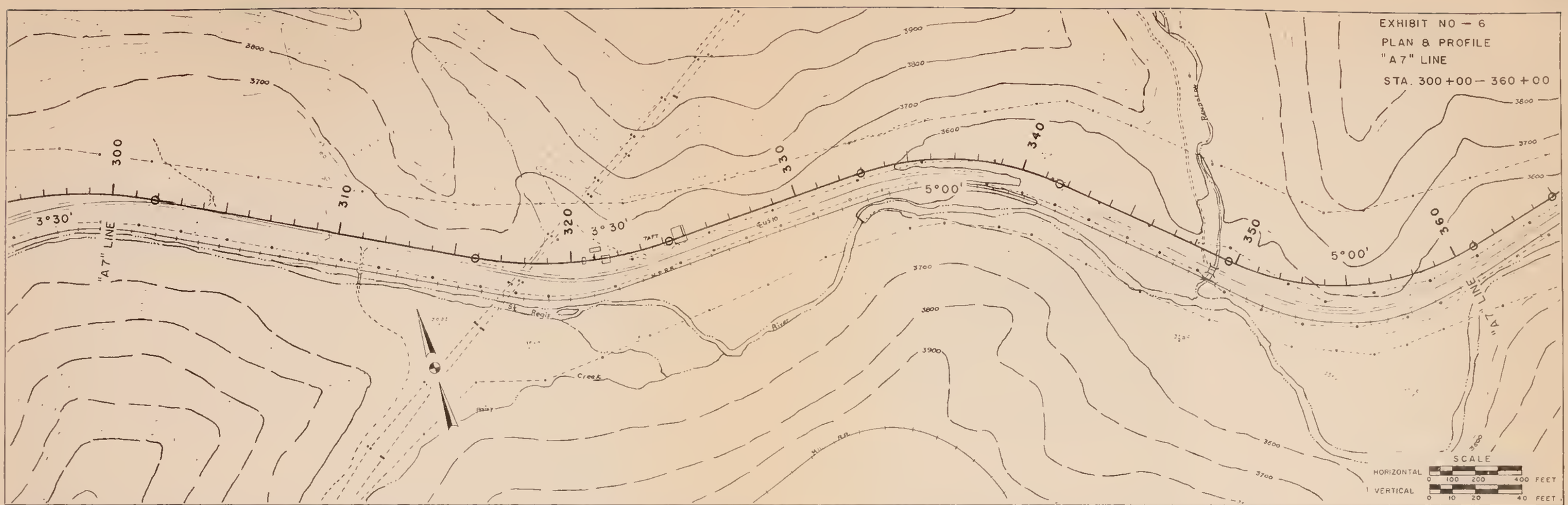
20
3700
80
60
40
20
3600

EXHIBIT NO – 6

PLAN & PROFILE

"A 7" LINE

STA. 300 + 00 – 360 + 00



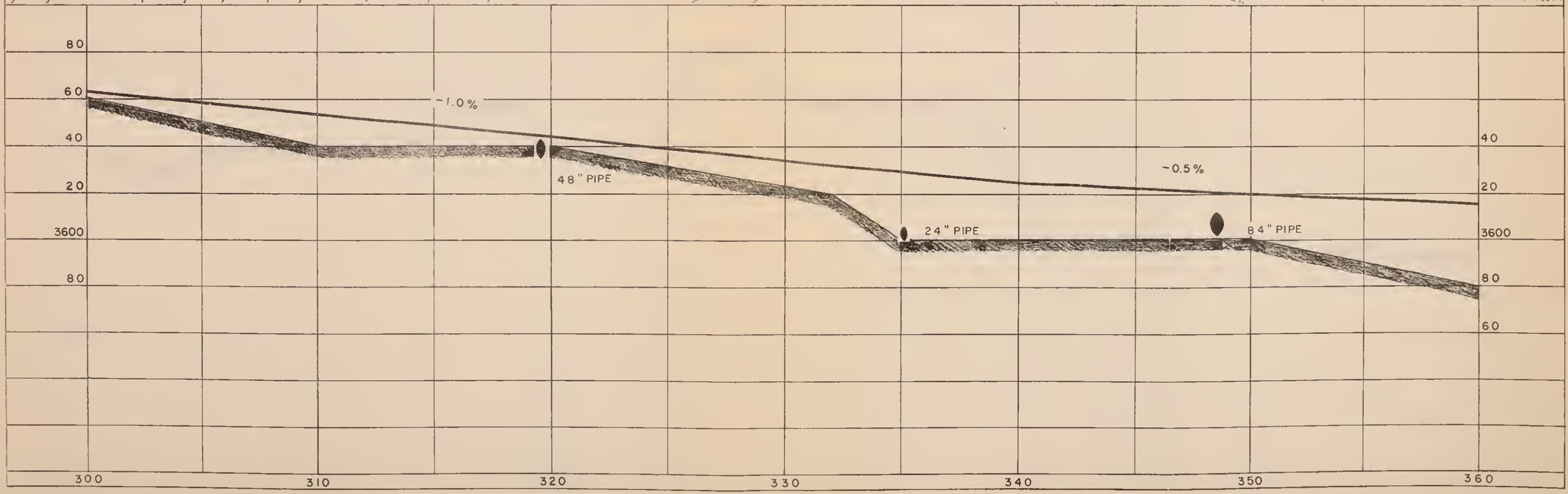


EXHIBIT NO. — 7
PLAN & PROFILE
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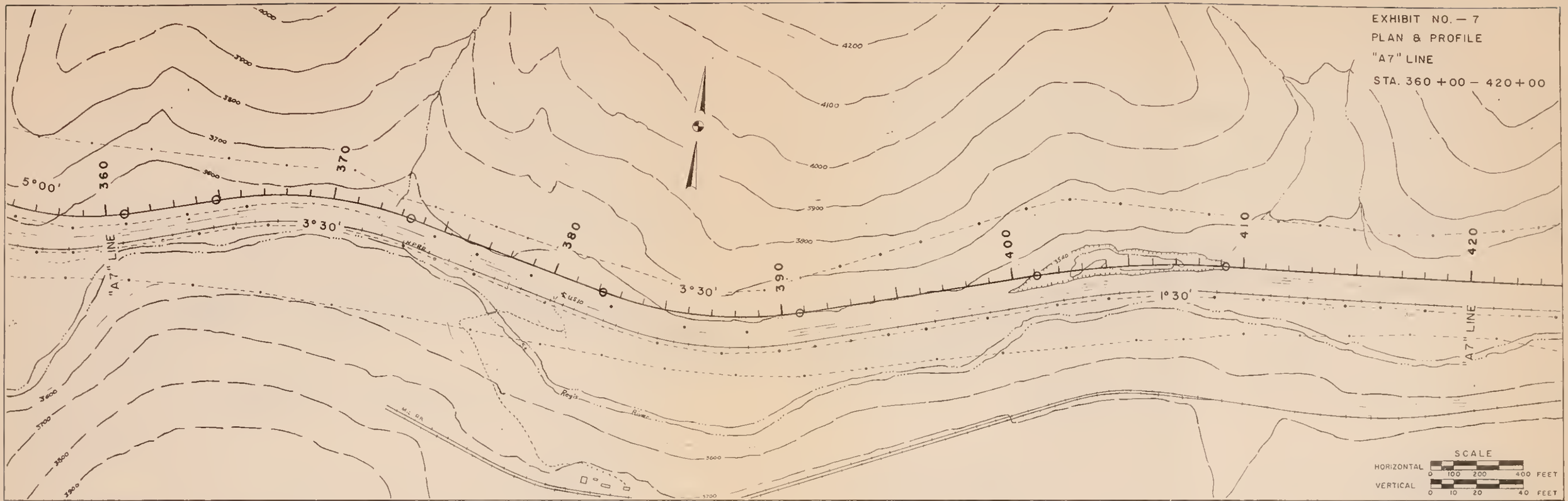
STA. 360 + 00 — 420 + 00



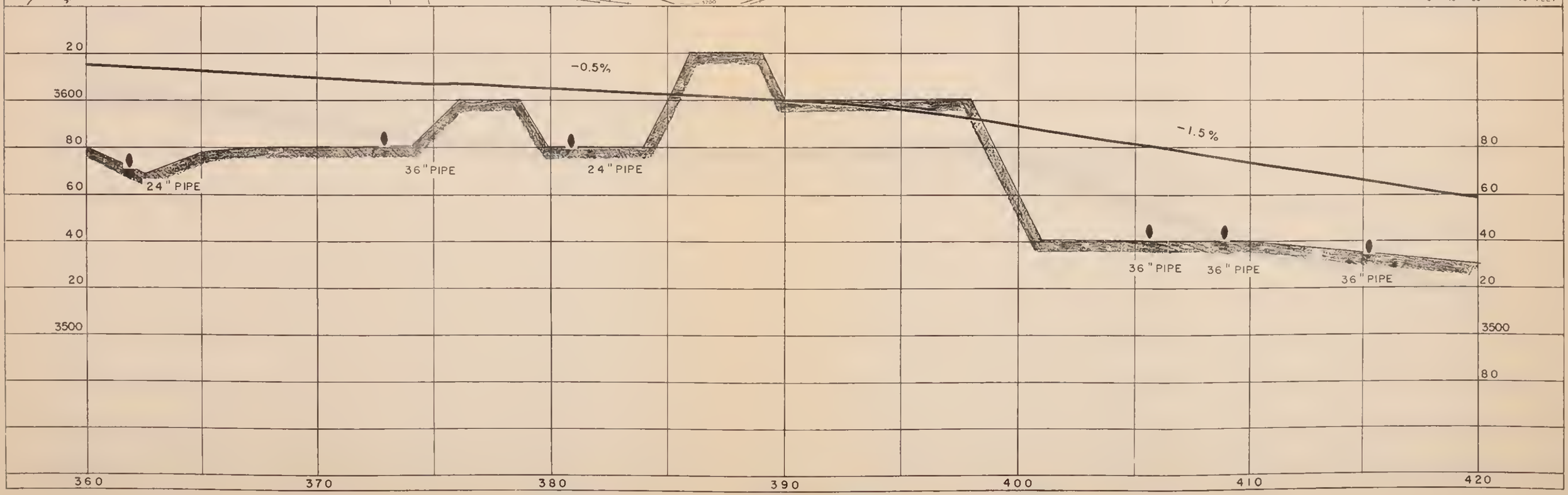


EXHIBIT NO. — 8

PLAN & PROFILE

"A 7" LINE

STA. 420+00 — 480+00

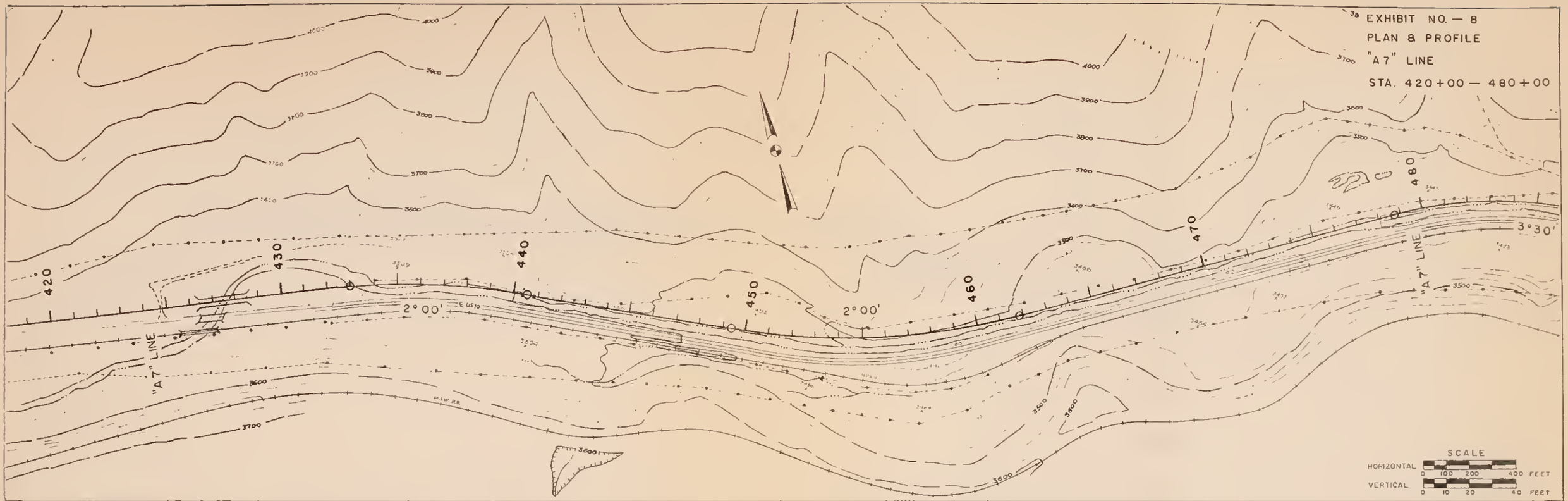
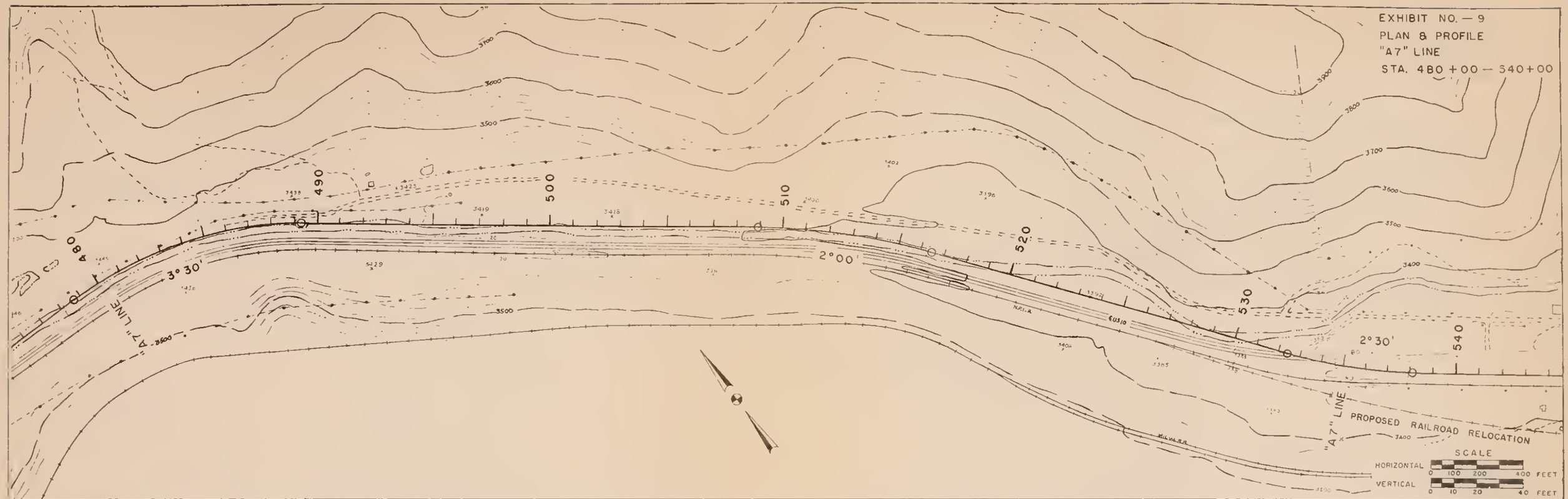


EXHIBIT NO. — 9
PLAN & PROFILE
"A7" LINE
STA. 480 + 00 — 540 + 00



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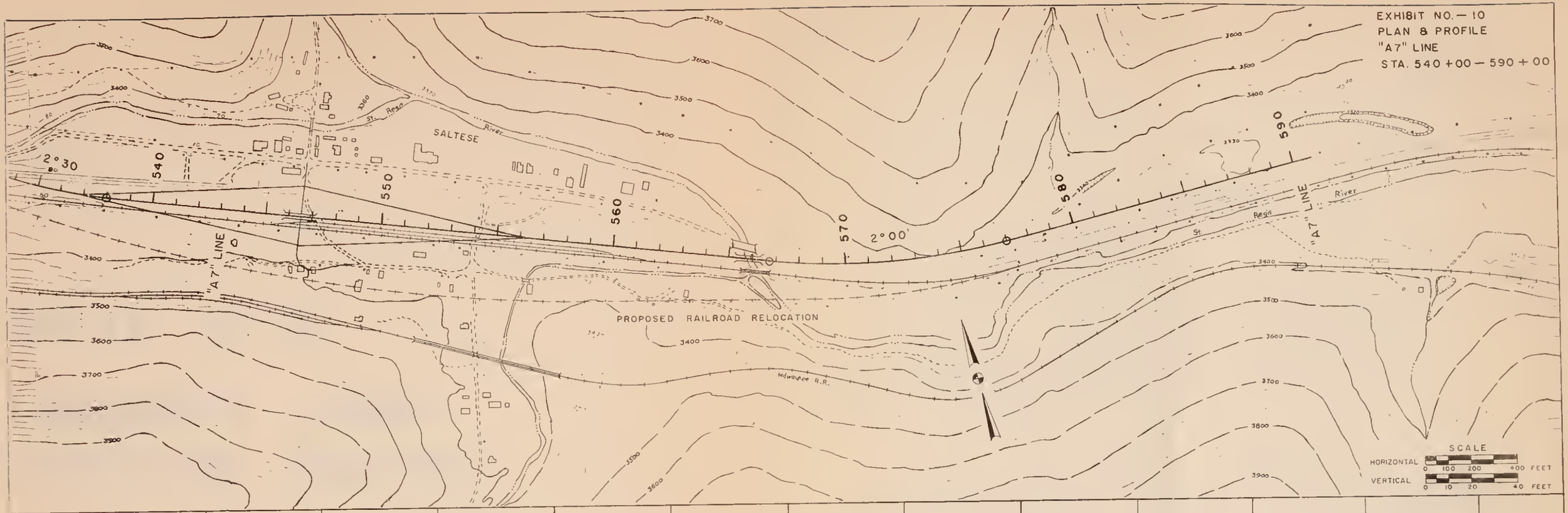
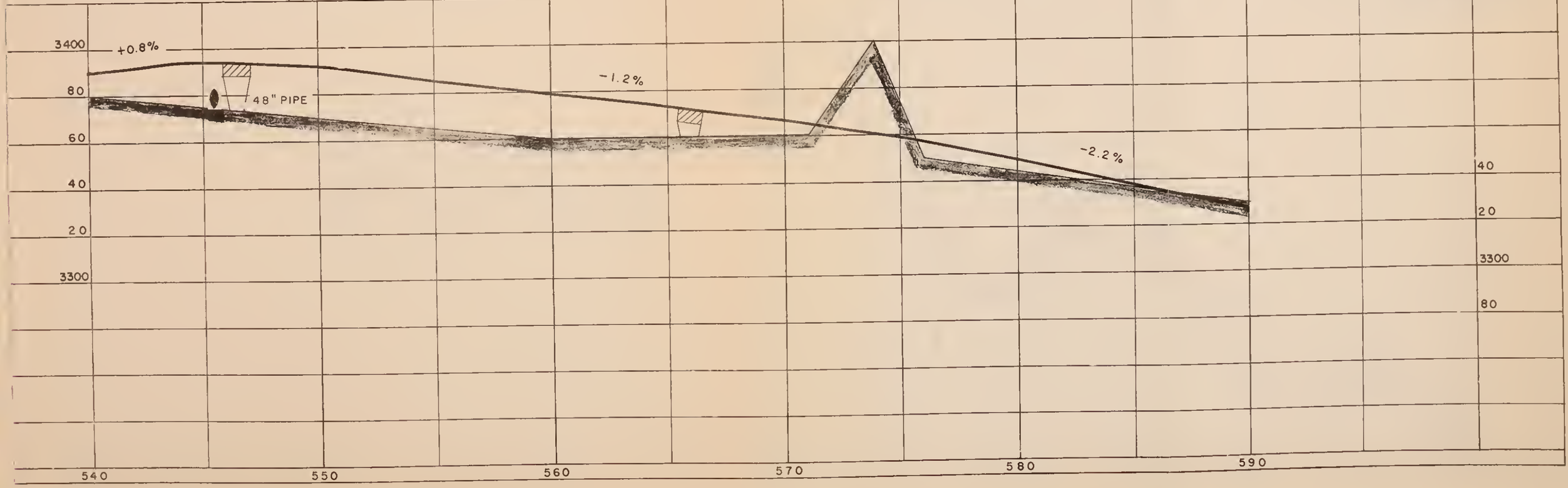
PLAN & PROFILE
"A7" LINE
STA. 540 + 00 — 590 + 00





EXHIBITS 11 TO 13

ROUTE A-5

LOOKOUT PASS SURFACE ROUTE

GRADES NOT OVER 5.0 %
CURVES NOT OVER 5°00'
TOTAL LENGTH 11.100 MILES

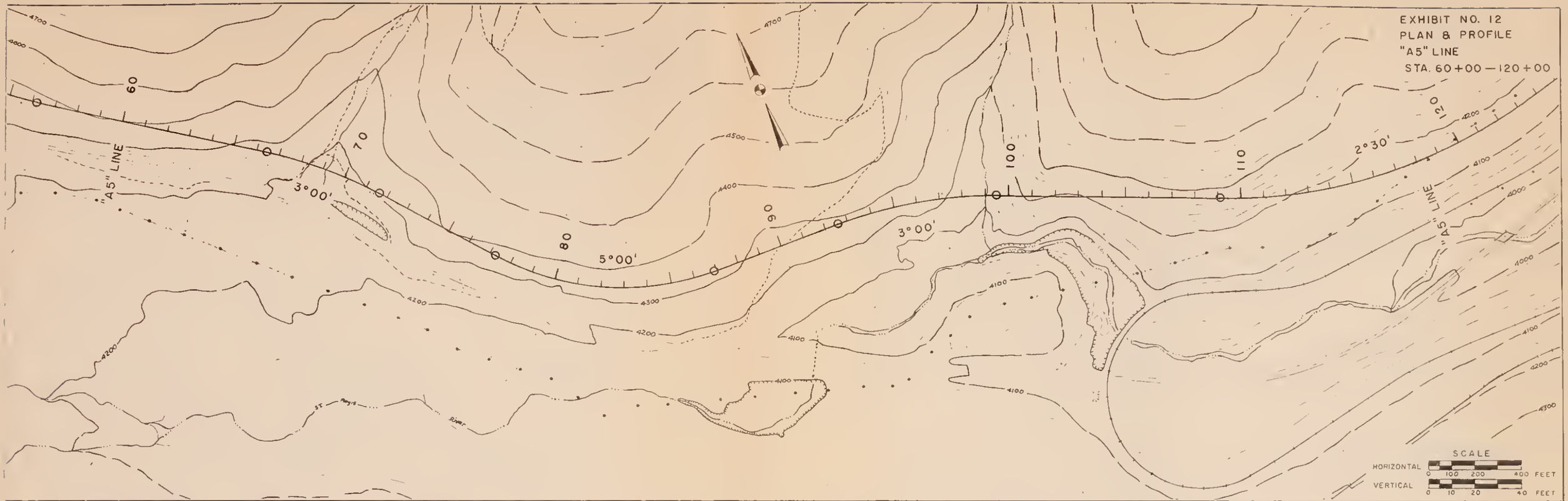
EXHIBIT NO 11
PLAN & PROFILE
"A5" LINE
STA 0+00 — 60+00

IDAHO
MONTANA
"A5" LINE
"A5" LINE
0+00
10
20
30
40
50
60
4°00'
4°00'
2°30'
3°00'
3°00'
5000
4900
4800
4700
4600
4500
4400
4300

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

+5.0%
-5.0%
24" PIPE
36" PIPE
24" PIPE
-5.0%
24" PIPE

EXHIBIT NO. 12
PLAN & PROFILE
"A5" LINE
STA. 60+00 — 120+00



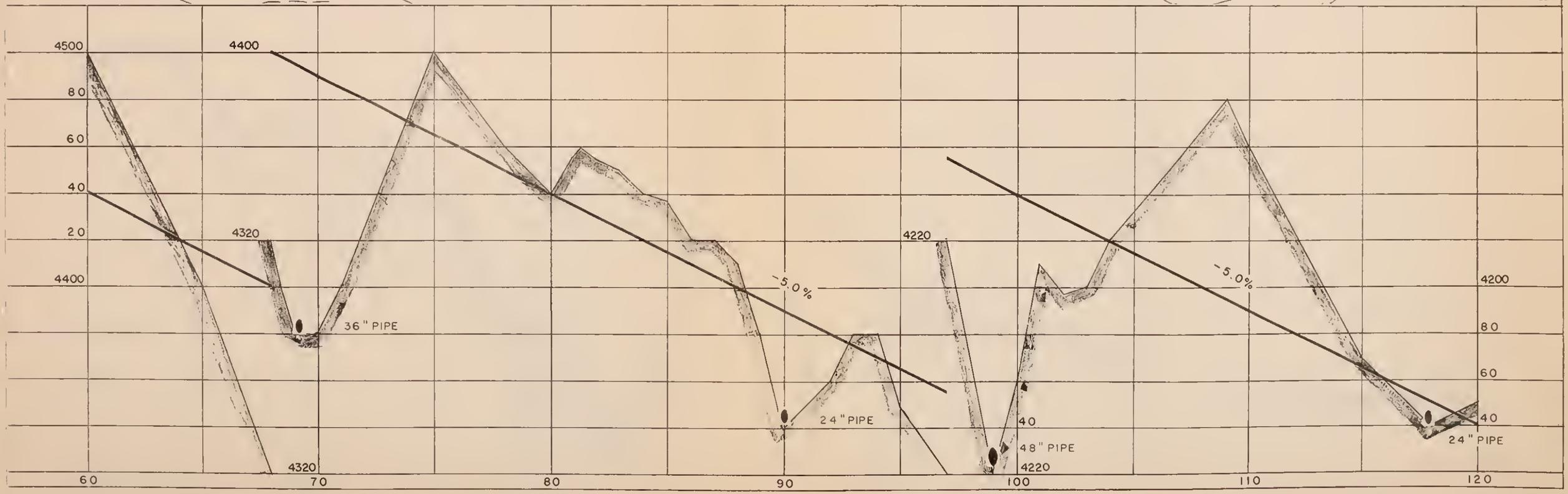


EXHIBIT NO. 13
PLAN & PROFILE
"A5" LINE
STA. 120+00 — 165+15

"A5" LINE

"A7" LINE

165+15 A5 LINE - BK
169+05 A7 LINE - AH

7°30'

2°30'

5°00'

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

120" PIPE

84" PIPE

36" PIPE

-5.0%

-5.0%

-3.0%

120 130 140 150 160 170 180

EXHIBITS 14 TO 21

ROUTE B - 7
MULLAN PASS SURFACE ROUTE VIA PACKER CREEK

GRADES NOT OVER 7.0 %
CURVES NOT OVER 6°00'
TOTAL LENGTH 9.030 MILES

EXHIBIT NO. — 14
PLAN & PROFILE
"87" LINE
STA. 0+00 — 60+00

IDAHO
MONTANA
"87" LINE
"87" LINE
Creek

0+00
1+00
2°30'
4°00'
2°00'
3°30'
3°30'

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

60
40
20
5100
-2.0%
36" PIPE
-4.5%
20
5000
80
5000
60
-4.5%
48" PIPE
20
4900
80
0+00
10
20
30
40
50
60

EXHIBIT NO.— 15
PLAN & PROFILE
"B7" LINE
STA. 60+00 — 120+00

"B7" LINE

3°30'

1°00'

2°00'

"B7" LINE

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

4900
80
60

-4.5%

-3.0%

36" PIPE

4720

4720

36" PIPE

-3.0%

4660

4660

36" PIPE

-3.0%

4700
80
60
40
20
4600

60 70 80 90 100 110 120

EXHIBIT NO.— 16
PLAN & PROFILE
"B7" LINE
STA. 120+00 — 180+00

"B7" LINE 2°00'

2°00'

2°00'

3°30'

"B7" LINE

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

4700
4600
4500
4400
4300

120 130 140 150 160 170 180

20
80

-3.0%

-3.0%

36" PIPE

36" PIPE

36" PIPE

36" PIPE

4540

4540

80
60
40
20
4500

EXHIBIT NO.— 17
PLAN & PROFILE
"87" LINE
STA. 180+00 — 240+00

"87" LINE

"87" LINE

"87" LINE

1°00'

3°30'

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

4500

-3.0%

-3.0%

-7.0%

-7.0%

4380

4380

4280

4280

48" PIPE

48" PIPE

24" PIPE

60
40
20
4500

4200
80
60
40

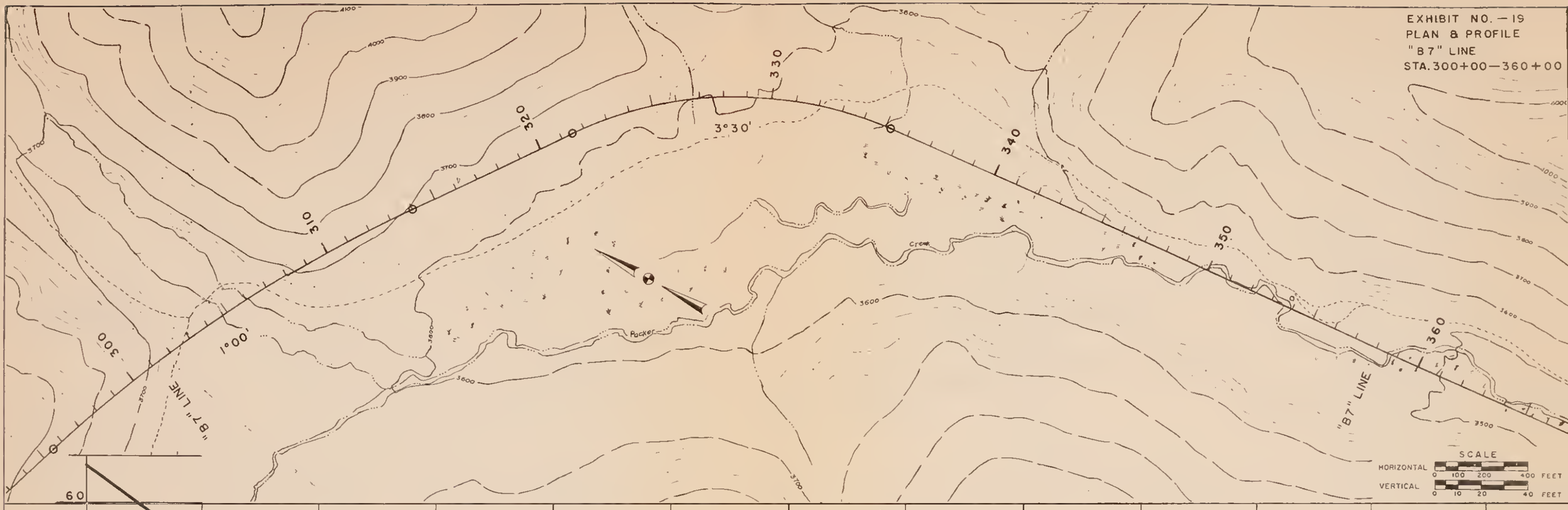
180 190 200 210 220 230 240

EXHIBIT NO. — 18
PLAN & PROFILE
"B7" LINE
STA. 240+00 — 300+00

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

"B7" LINE
3°30'
1°00'
240
250
260
270
280
290
300
4300
4200
4100
4000
3900
3800
3700
-7.0%
24" PIPE
48" PIPE
36" PIPE
4000
3820
8.0
80
60
40
20
4100

EXHIBIT NO. — 19
PLAN & PROFILE
"B 7" LINE
STA. 300+00 — 360+00



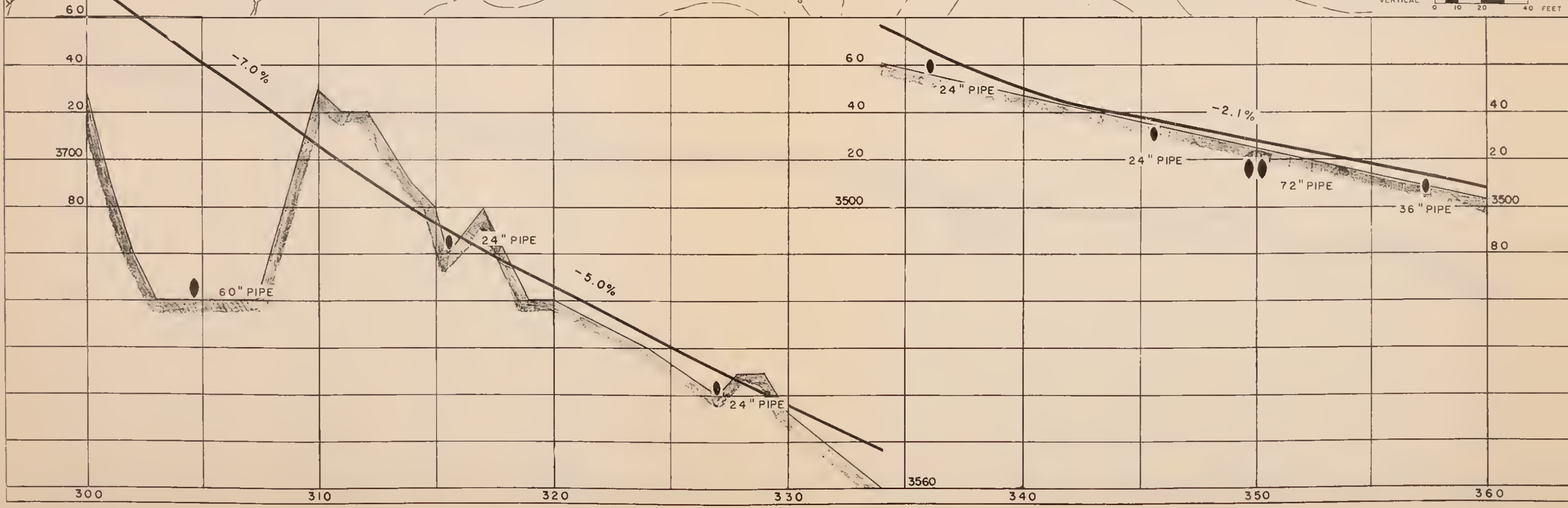
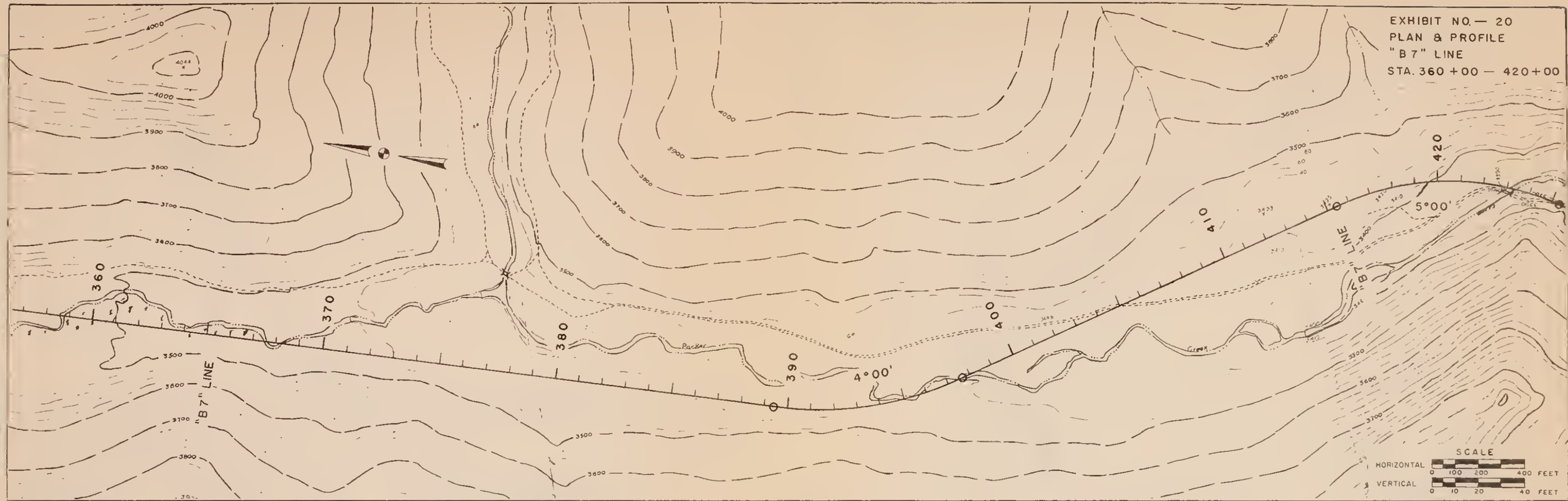


EXHIBIT NO.— 20
PLAN & PROFILE
"B 7" LINE
STA. 360 + 00 — 420 + 00



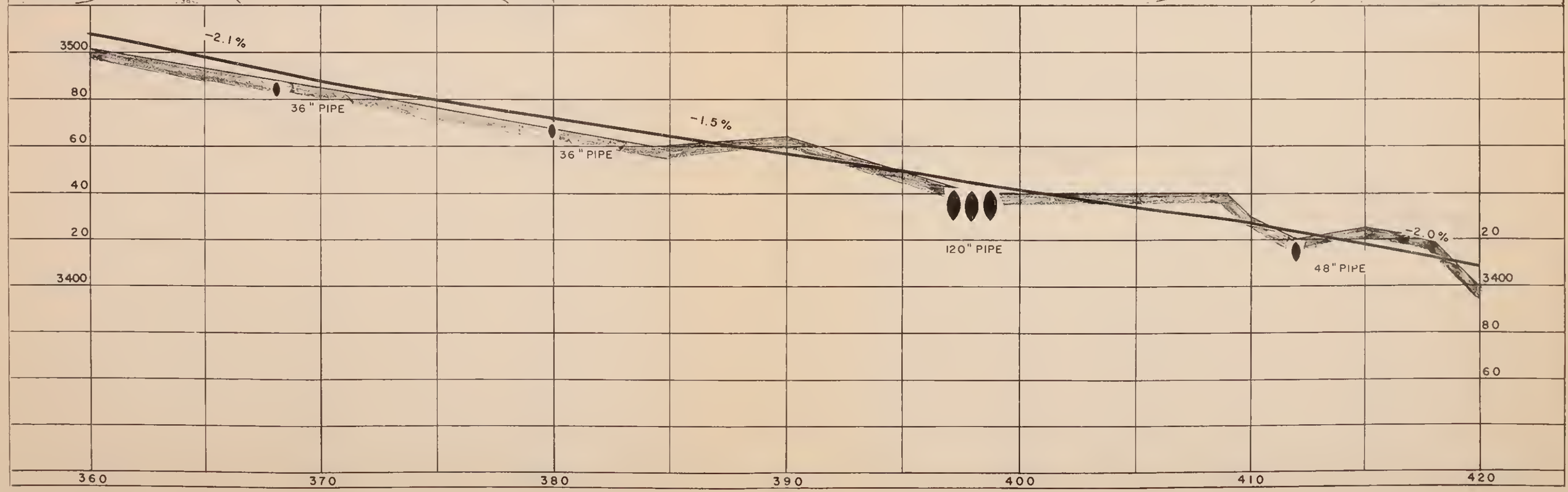
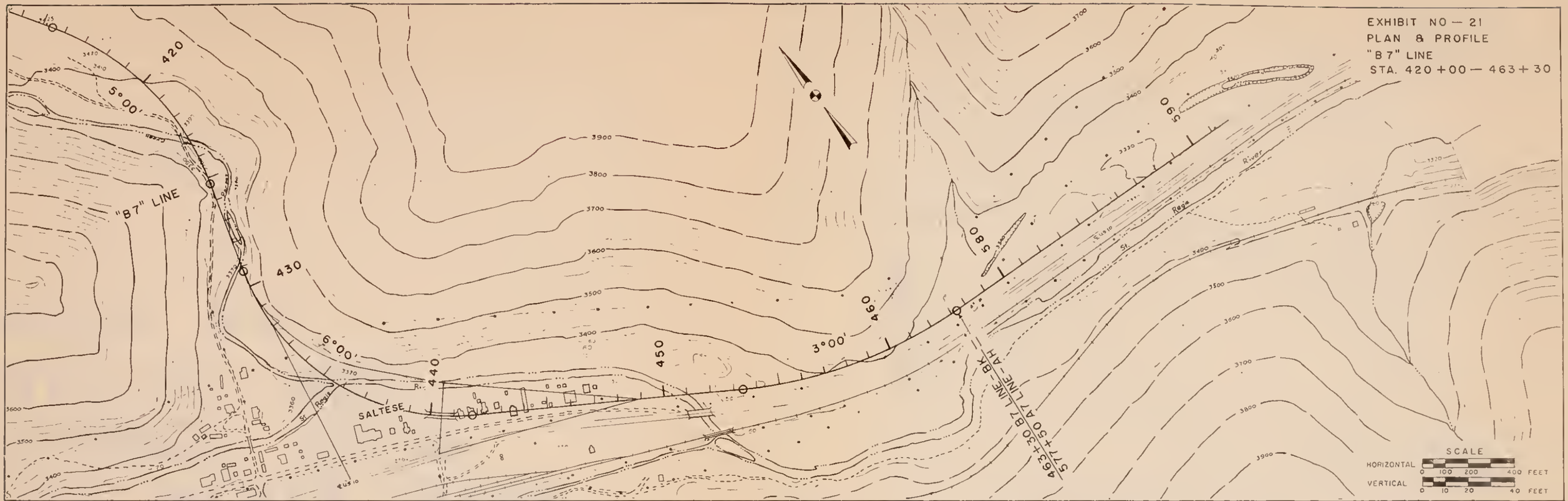
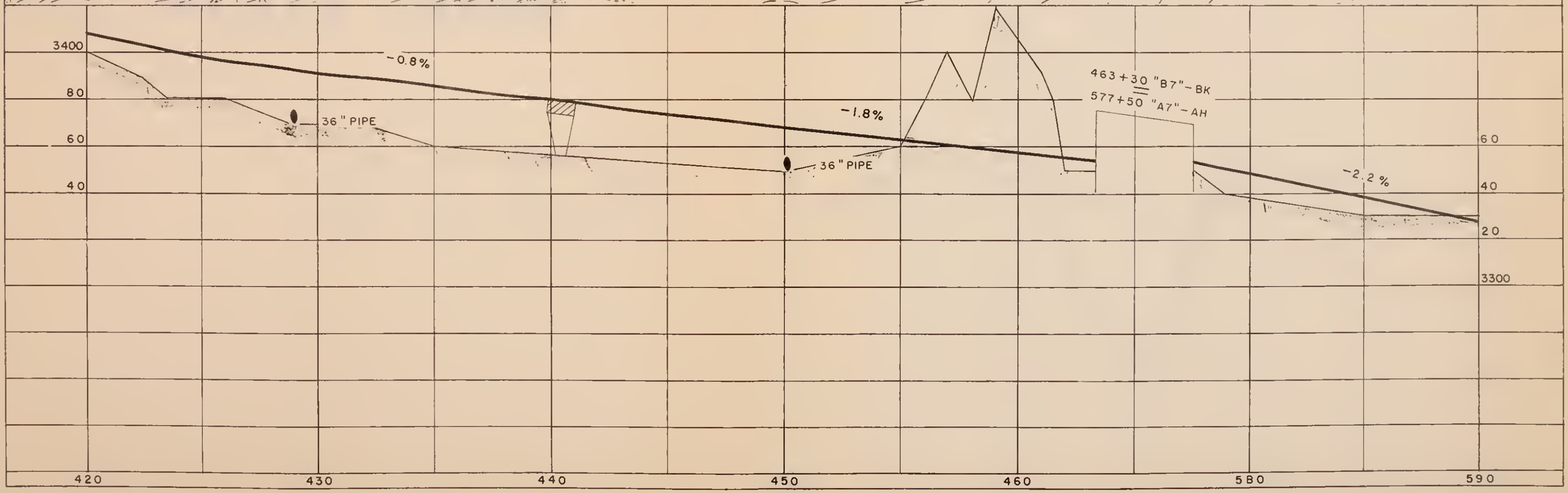


EXHIBIT NO — 21
PLAN & PROFILE
"B 7" LINE
STA. 420 + 00 — 463 + 30





EXHIBITS 22 TO 27

ROUTE B - 5

MULLAN PASS SURFACE ROUTE VIA PACKER CREEK

GRADES NOT OVER 5.0 %
CURVES NOT OVER 7°30'
TOTAL LENGTH 9.301 MILES

EXHIBIT NO. — 22
PLAN & PROFILE
"85" LINE
STA 156 + 00 — 180 + 00

"87" LINE

"85" LINE

156+00 "B7" LINE-BK = 156+00 "B5" LINE-AH

2°00'

2°00'

3°00'

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

-3.0%

-3.0%

-2.6%

36" PIPE

36" PIPE

36" PIPE

36" PIPE

4560

4560

4700

20

80

60

80

60

40

20

4500

120

130

140

150

160

170

180

EXHIBIT NO.— 23
PLAN & PROFILE
"B5" LINE
STA. 180 + 00 — 240 + 00

3°00'

"B5" LINE

1°00'

1°00'

"B5" LINE

180 190 200 210 220 230 240

4700 4600 4500 4400 4300 4200

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

4540

-2.6%

-2.6%

-5.0%

-5.0%

4380

4380

4300

4300

48" PIPE

24" PIPE

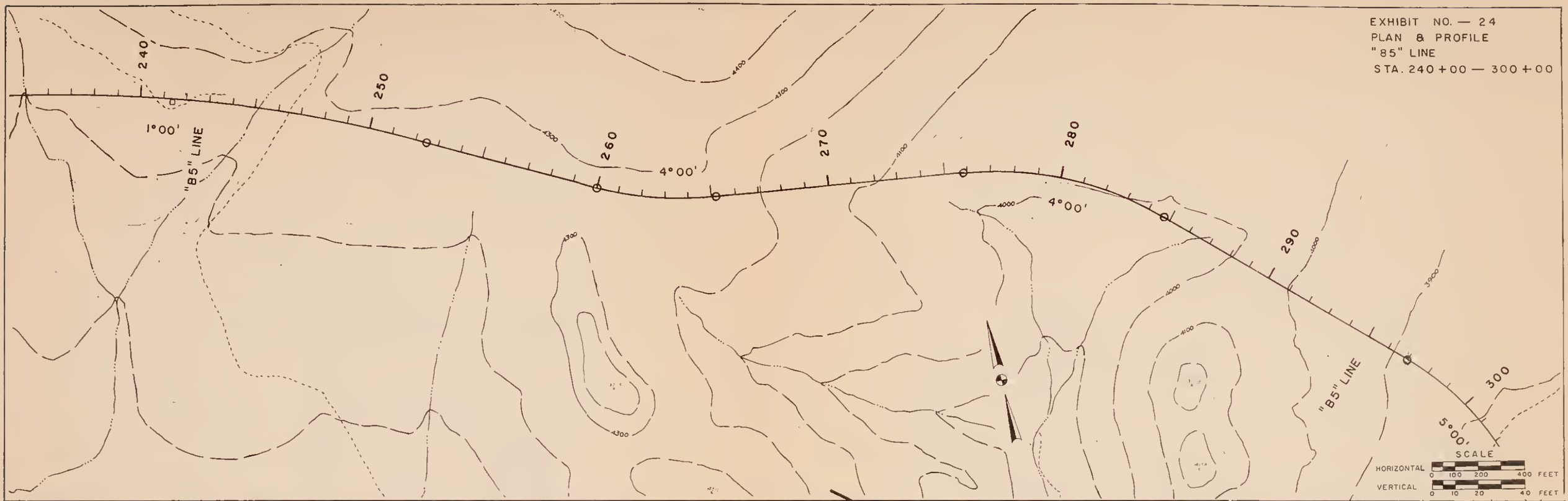
48" PIPE

60 40 20 4500

4300 80 60 40 20 4200

180 190 200 210 220 230 240

EXHIBIT NO. — 24
PLAN & PROFILE
"85" LINE
STA. 240+00 — 300+00



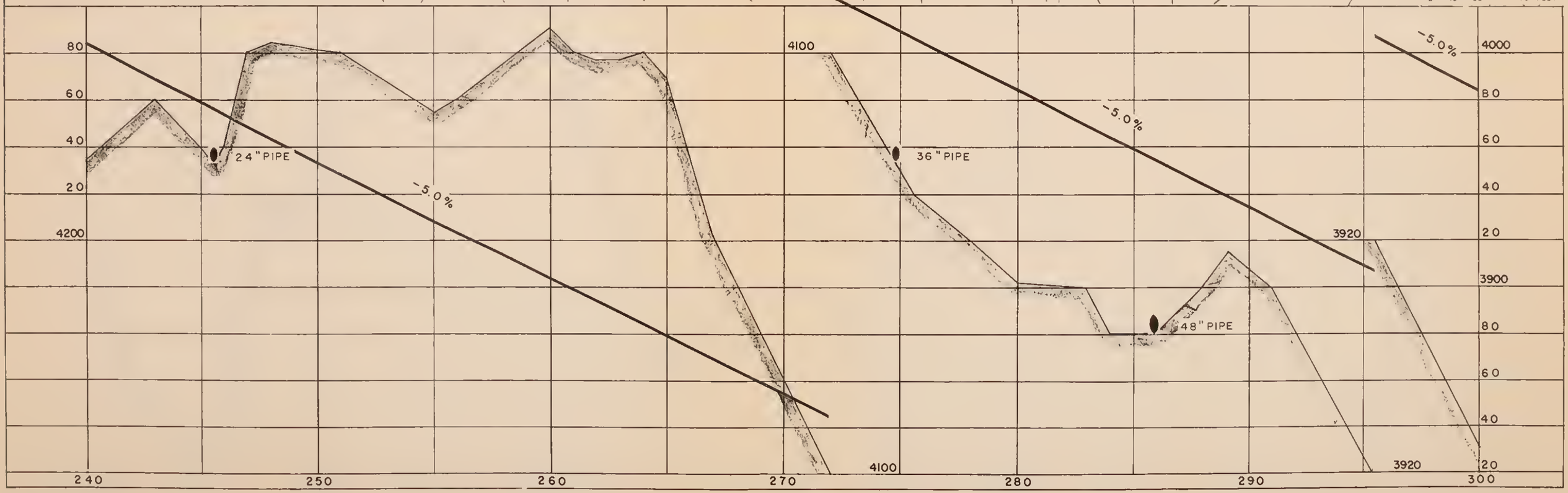


EXHIBIT NO. — 25
PLAN & PROFILE
" B5" LINE
STA. 300+00 — 360+00

EXHIBIT NO. — 26
PLAN & PROFILE
"B5" LINE
STA. 360 + 00 — 420 + 00

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

"B5" LINE

4°00'

2°00'

Packer

24" PIPE

-5.0%

84" PIPE

-5.0%

-2.0%

3520

EXHIBIT NO.— 27
PLAN & PROFILE
"B5" LINE
STA. 420+00 — 427+70

427+70 BK "85" LINE =
413+40 AH "87" LINE

463+30 B5 LINE - BK
577+50 AT LINE - AH

2°00'
5°00'
6°00'
3°00'

SALTESE

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

427+70 "B5" — BK
413+40 "87" — AH

-2.0%
-0.8%
-1.8%

48" PIPE
36" PIPE

420 420 430 440 450 460

EXHIBITS 28 TO 33

ROUTE C - 7

MULLAN PASS SURFACE ROUTE VIA RANDOLPH CREEK

GRADES NOT OVER 7.0 %
CURVES NOT OVER 7°00'
TOTAL LENGTH 10.352 MILES

EXHIBIT NO. — 2B
PLAN & PROFILE
"C 7" LINE
STA 0+00 — 60+00

IDAHO
MONTANA
"C7" LINE
"C7" LINE

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

-1+00
0+00
4°00'
2°30'
2°00'
3°30'
2°30'
10
20
30
40
50
60

5100
4900
4980

-2.0%
-4.5%
-4.5%
-7.0%

36" PIPE
48" PIPE

60
40
20
5100
40
20
4900
80
60
4980

0+00 10 20 30 40 50 60

EXHIBIT NO. — 29
PLAN & PROFILE
"C7" LINE
STA. 60+00— 120+00

"C7" LINE

"C7" LINE

2°30'

2°30'

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

4900
80
60
40
20

-7.0%

36" PIPE

4720

4720

-7.0%

36" PIPE

80
60
4540

-4.0%

-4.0%

36" PIPE

4540

80
60
40
20
4500

60 70 80 90 100 110 120

EXHIBIT NO. — 30
PLAN & PROFILE
"C7" LINE
STA. 120 + 00 — 180 + 00

"C7" LINE

120

130

140

150

160

170

180

2°30'

2°30'

2°00'

-4.0%

-7.0%

-7.0%

-7.0%

36" PIPE

36" PIPE

48" PIPE

36" PIPE

24" PIPE

4440

4260

4500

4300

4200

4100

80

60

40

20

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

EXHIBIT NO. — 31
PLAN & PROFILE
"C 7" LINE
STA. 180 + 00 — 240 + 00

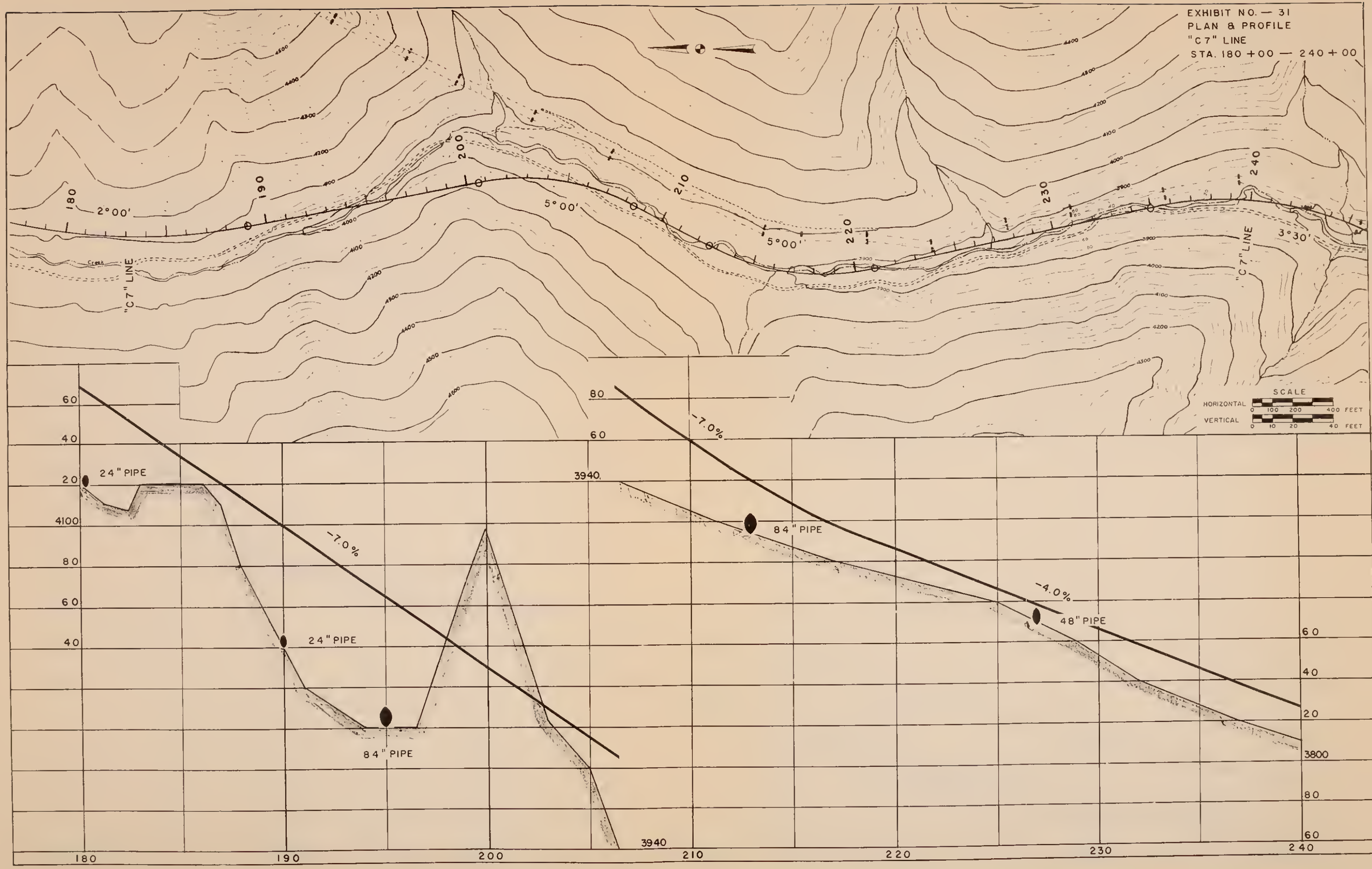


EXHIBIT NO. — 32
PLAN & PROFILE
"C 7" LINE
STA. 240 + 00 — 300 + 00

316 + 20 "C 7" LINE-BK
360 + 60 "A 7" LINE-AH

"C 7" LINE

"C 7" LINE

3°30'

3°30'

7°00'

Creek

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

-4.0%

-2.4%

48" PIPE

72" PIPE

24" PIPE

24" PIPE

24" PIPE

24" PIPE

3800
80
60
40
20
3700

3700
80
60
40
20

240 250 260 270 280 290 300

EXHIBIT NO. — 33
PLAN & PROFILE
"C7" LINE
STA. 300 + 00 — 316 + 20

"C7" LINE

"A7" LINE

316+20 "C7" LINE-BK
360+60 "A7" LINE-AH

7°00'

3°30'

3°30'

1°30'

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

-2.4%

84" PIPE

316 + 20 "C7" — BK
360 + 60 "A7" — AH

-0.5%

36" PIPE

24" PIPE

-1.5%

EXHIBITS 34 TO 39

ROUTE C - 5
MULLAN PASS
SURFACE ROUTE
VIA RANDOLPH CREEK

GRADES NOT OVER 5.0 %
CURVES NOT OVER 7°00'
TOTAL LENGTH 10.803 MILES

EXHIBIT NO. — 34
PLAN & PROFILE
"C5" LINE
STA. 0+00 — 60+00

IDAHO
MONTANA
"C5" LINE
"C5" LINE

0+00
10
20
30
40
50
60
4°00'
2°30'
2°00'
3°30'
3°30'

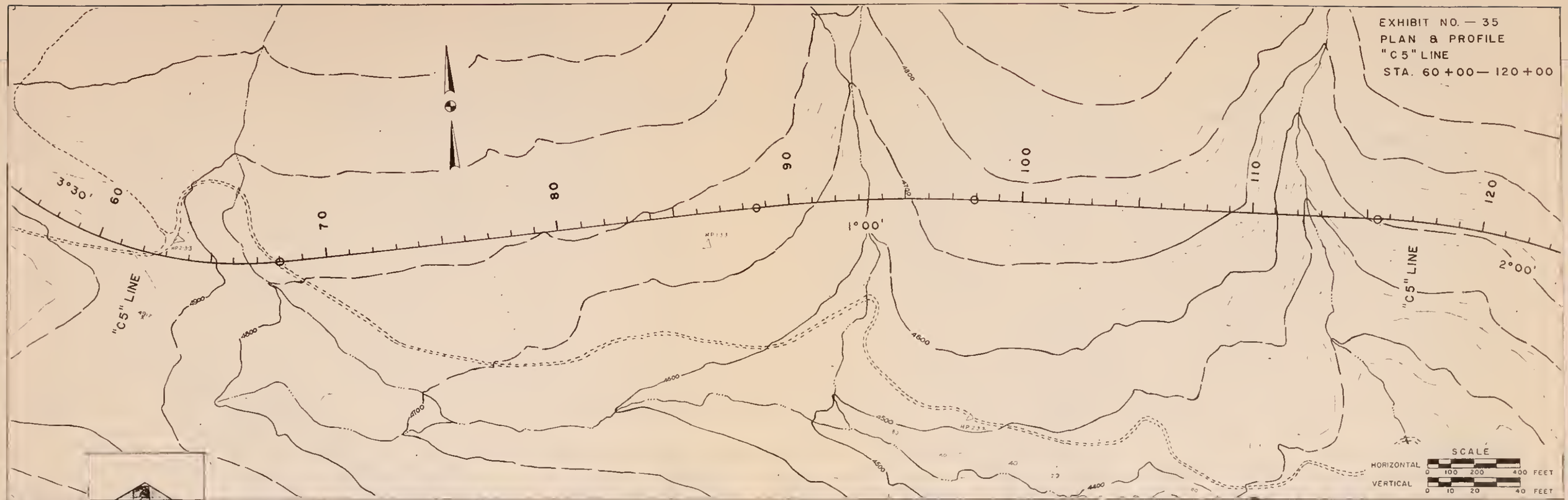
SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

5100
4900
4980

-2.0%
-4.5%
-4.5%

36" PIPE
48" PIPE

EXHIBIT NO. — 35
PLAN & PROFILE
"C5" LINE
STA. 60+00 — 120+00



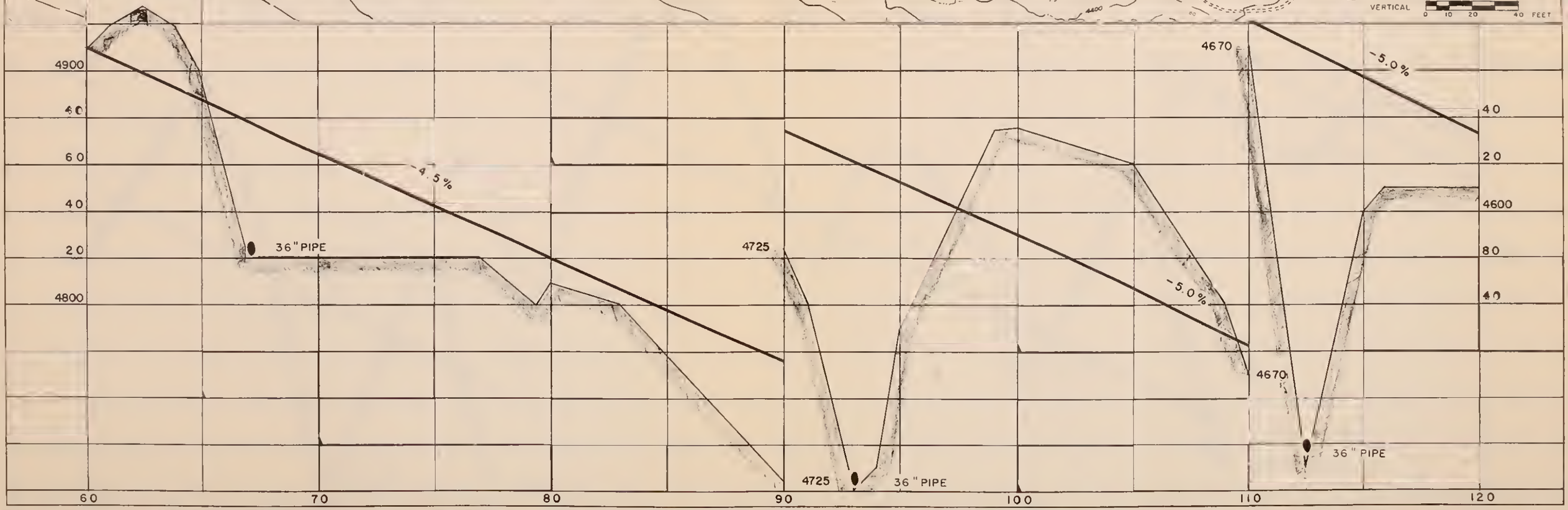


EXHIBIT NO. — 36
PLAN & PROFILE
"C5" LINE
STA. 120+00 — 180+00

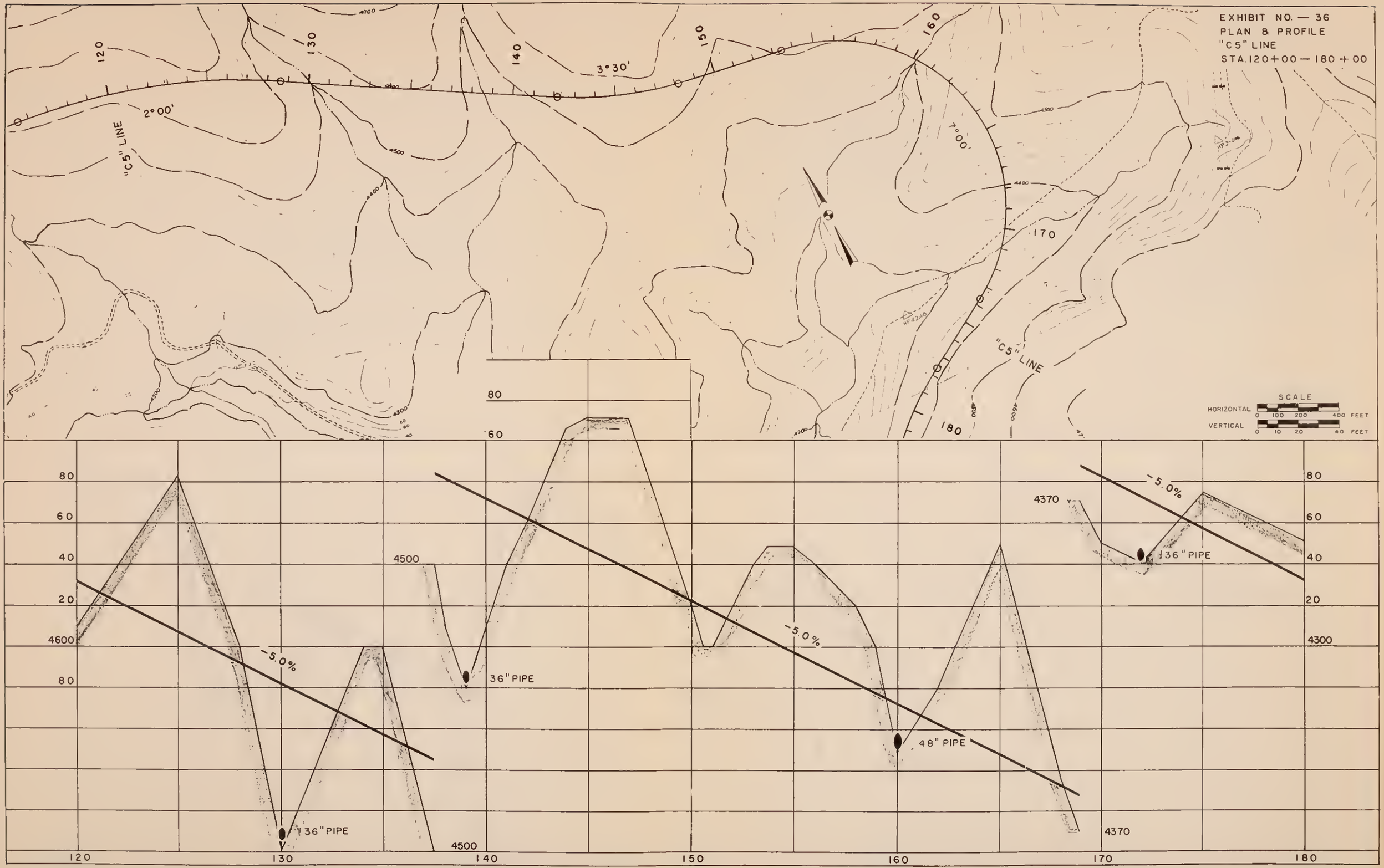


EXHIBIT NO. — 37
PLAN & PROFILE
"C5" LINE
STA. 180 + 00 — 240 + 00

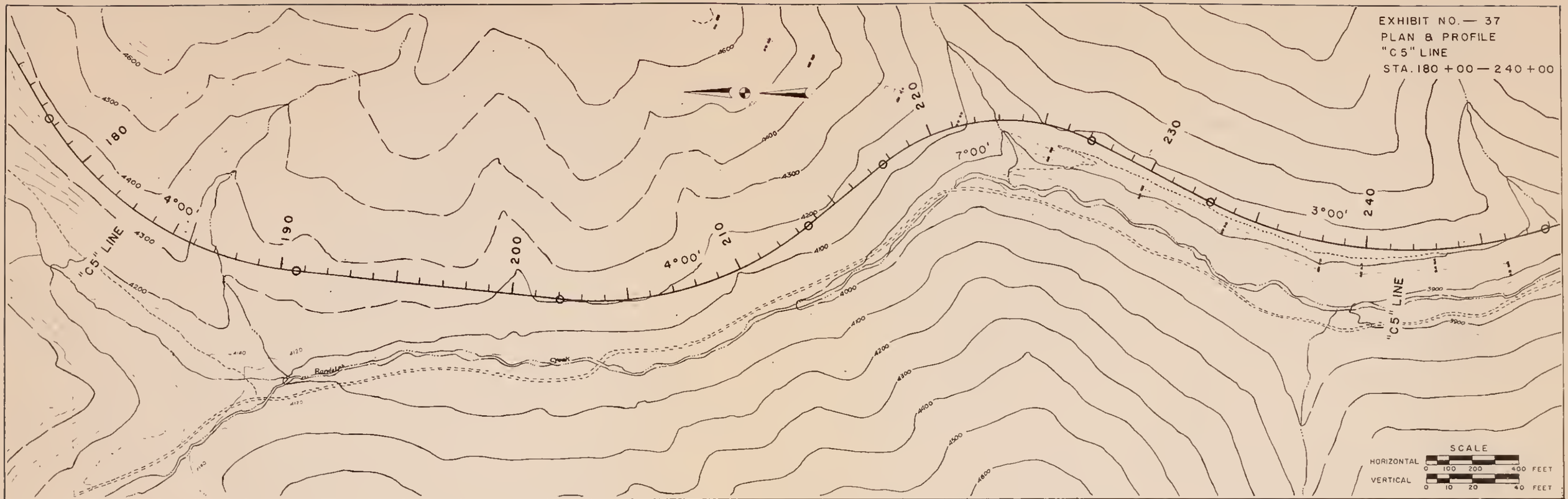
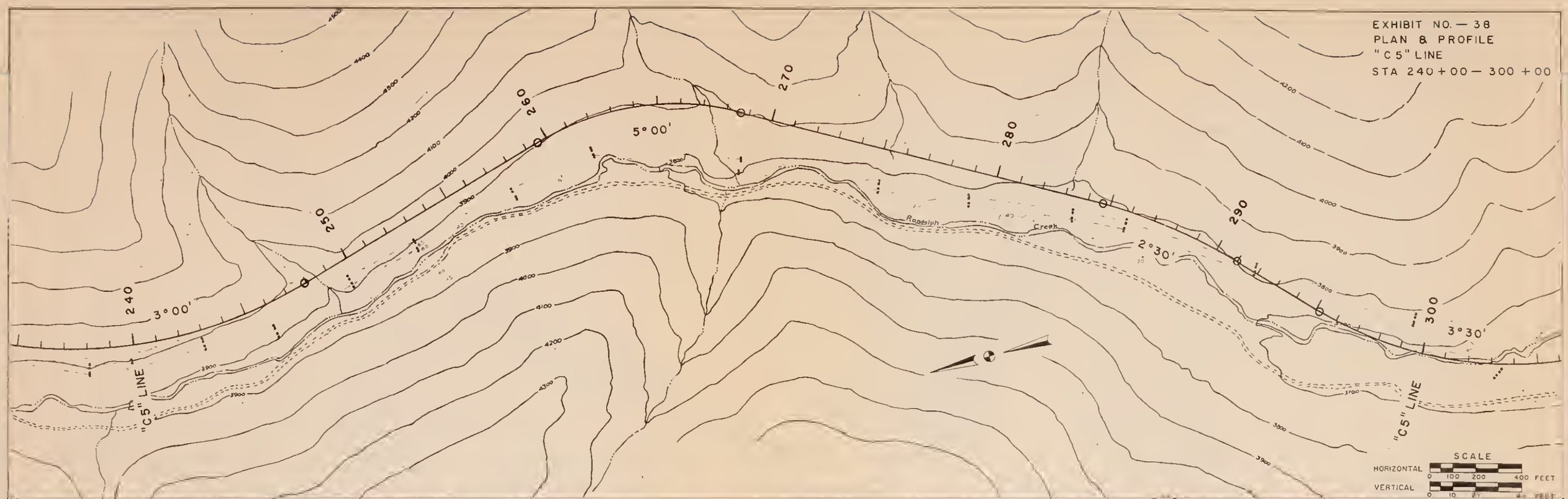


EXHIBIT NO. — 38
PLAN & PROFILE
"C 5" LINE
STA 240 + 00 — 300 + 00



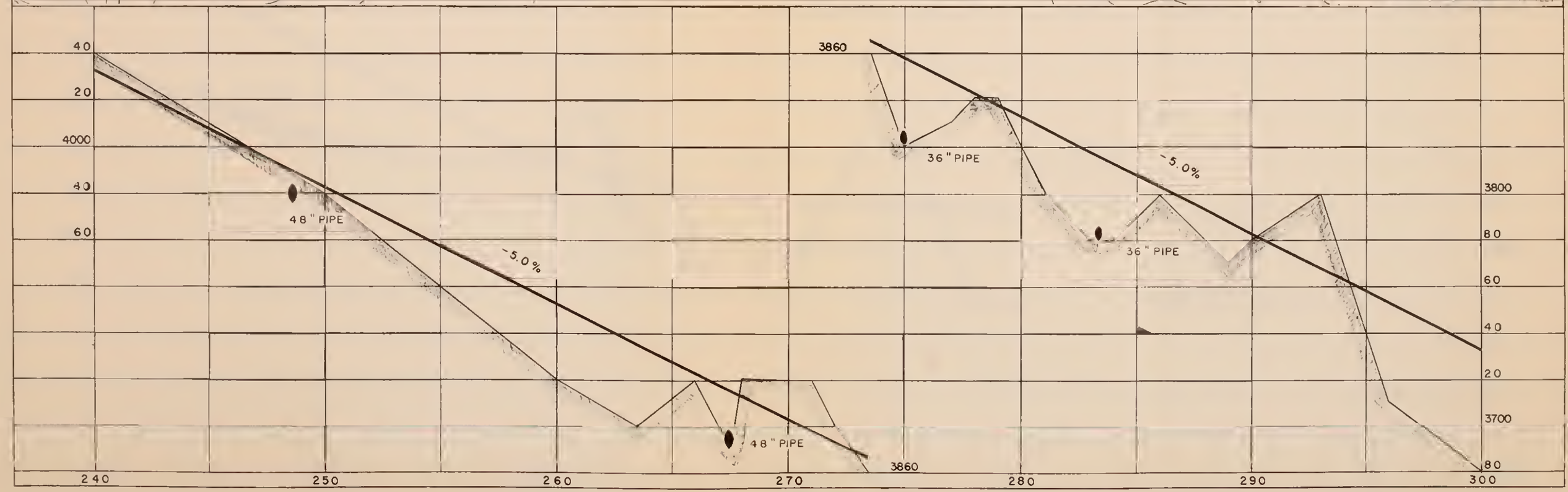


EXHIBIT NO. — 39
PLAN & PROFILE
"C5" LINE
STA. 300+00 — 340+00

"C5" LINE
"A7" LINE
3°30'
7°00'
300
310
320
330
340+00 "C5" LINE-BK
360+60 "A7" LINE-AH
370

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

-5.0%
-0.8%
-0.5%
84" PIPE
84" PIPE
24" PIPE
340+00 "C5"—BK
360+60 "A7"—AH

20
3700
80
60
40
20
3600
80
20
3600
80
60
40
20
3500

300 310 320 330 340 370

EXHIBITS 40 AND 41

ROUTE D

ST. REGIS PASS TUNNEL ROUTE

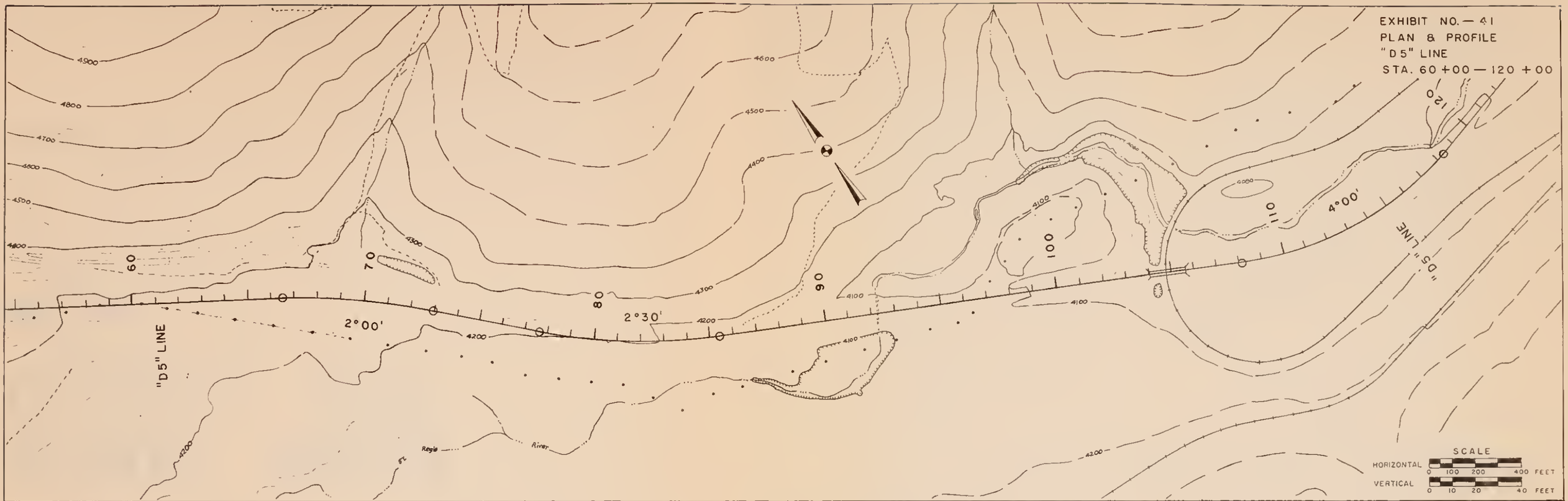
GRADES NOT OVER 5.0 %
CURVES NOT OVER 5°00'
TOTAL LENGTH 11.038 MILES
(EXCLUDING TUNNEL)

EXHIBIT NO.— 40
PLAN & PROFILE
"D5" LINE
STA. 0+00 — 60+00

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

"D5" LINE
0+00
7+20 PORTAL
5°00'
4°00'
3°30'
"D5" LINE
4500
4400
4300
4320
+5.0%
-3.4%
-4.4%
24" PIPE
24" PIPE
48" PIPE
4320
0+00
10
20
30
40
50
60

EXHIBIT NO. — 41
PLAN & PROFILE
"D5" LINE
STA. 60 +00 — 120 +00



EXHIBITS 42 AND 43

ROUTE E

LOOKOUT PASS TUNNEL ROUTE

GRADES NOT OVER 5.4 %
CURVES NOT OVER 5°00'
TOTAL LENGTH 11.018 MILES
(EXCLUDING TUNNEL)

EXHIBIT NO. — 42
PLAN & PROFILE
"E" LINE
STA. 0+00 — 60+00

0+00

8+25 PORTAL

"E" LINE

2°00'

3°00'

"E" LINE

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

4520

48" PIPE

24" PIPE

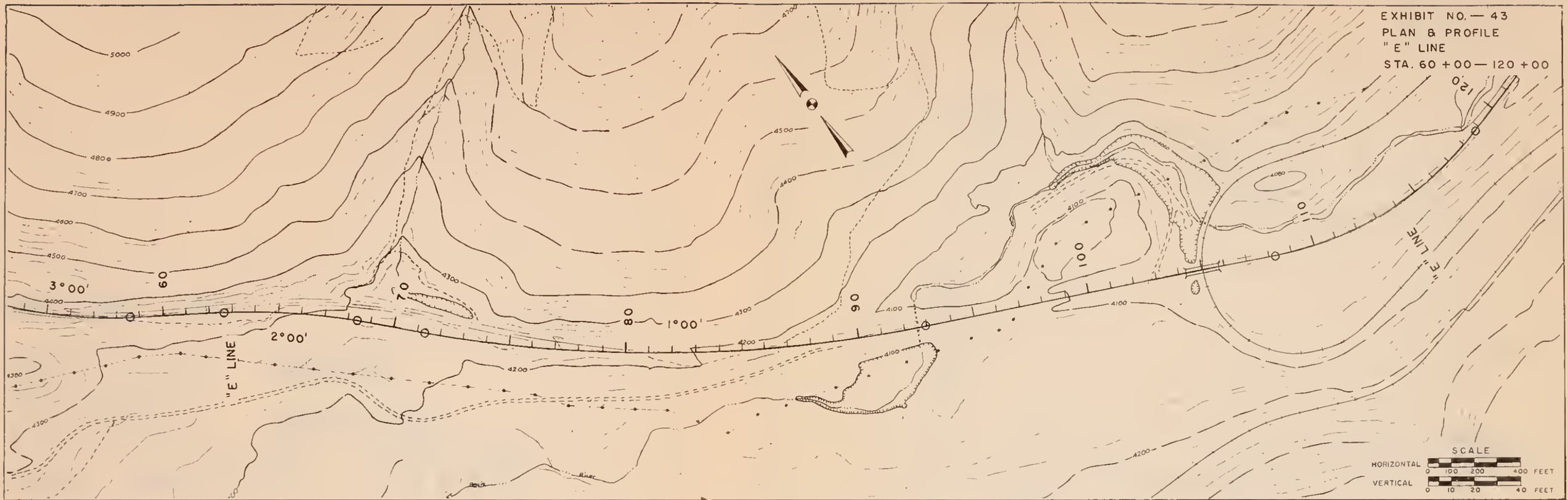
24" PIPE

-5.4%

-5.4%

0+00 10 20 30 40 50 60

EXHIBIT NO. — 43
PLAN & PROFILE
"E" LINE
STA. 60 + 00 — 120 + 00



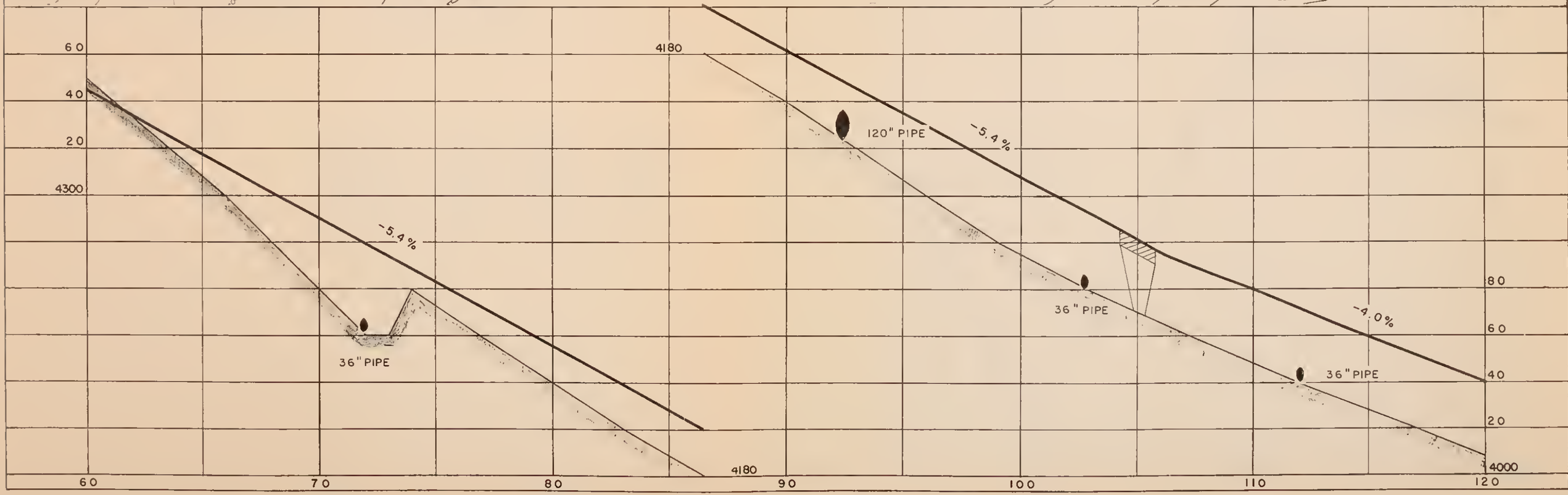


EXHIBIT 44

ROUTE F
MULLAN PASS TUNNEL ROUTE VIA PACKER CREEK

GRADES NOT OVER 5.0 %
CURVES NOT OVER 6°00'
TOTAL LENGTH 8.744 MILES

EXHIBIT NO.— 44
PLAN & PROFILE
" F" LINE
STA. 0+00 — 60+00

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

IDAHO
MONTANA

"F" LINE

0+00

10

14+10 PORTAL

20

2°00'

30

40

3°30'

50

60

3°30'

"F" LINE

-4.5%

+4.0%

36" PIPE

48" PIPE

4840

4840

5020
5000
80
60
80
20
4900
80
60
40

0+00 10 20 30 40 50 60

20
4900
80
60
40

EXHIBITS 45 TO 52 - A LINES
EXHIBITS 53 TO 59 - B LINES
EXHIBITS 60 AND 61 - C LINES

GEOLOGIC DATA

EXHIBIT NO. — 45
GEOLOGY
"A" LINES
STAS. 0 +00 — 60 +00

Qt — Principally surfaces on gravels, some on Lake Missoula lacustrine deposits and some on bedrock

pCw — Interbedded, fine-grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'

pCs — Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

pCrb — Undifferentiated quartzites, including Revett and Burke equivalents. Predominantly light-grey impure quartzites, ranging from pure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick

Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side

Zone of shearing

Strike and dip of beds

IDAHO
MONTANA

"A7" LINE
"A5" LINE
"A3" LINE
"A1" LINE
"A0" LINE
"A5" LINE
"A7" LINE

LOOKOUT SYNCLINE

0+00
10
20
30
40
50
60

4°00'
2°30'
3°00'
3°30'

pCs
Qt
pCw
pCrb

SCALE
HORIZONTAL
0 100 200 400 FEET

EXHIBIT NO. — 46
GEOLOGY
"A" LINES
STAS. 90+00 — 150+00

p€s
p€rb
Qt
"A5" LINE
"A7" LINE
"A" LINE
140
150
90
100
110
120
130
7°30'
5°00'
3°00'
2°30'
4°00'

Qt — Principally surfaces on gravels, some on Lake Missoula lacustrine deposits and some on bedrock

p€rb — Interbedded, fine-grained light-grey, somewhat limy quartzite and dark-grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some siltzites are common in lower 1000'

p€s — Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

p€rb — Undifferentiated quartzites, including Havelland Burke equivalents. Predominantly light-grey impure quartzites, ranging from pure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick

U D ↑65 ? — Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side

Zone of shearing

Strike and dip of beds

SCALE
HORIZONTAL
0 100 200 400 FEET

EXHIBIT NO — 47
GEOLOGY
"A" LINES
STAS. 160 + 00 — 230 + 00

FAULT CONTACT

FAULT CONTACT

165+15 "A5" LINE-BK
169+05 "A7" LINE-AH

"A7" LINE

4°30'

5°00'

3°00'

1°30'

160 170 180 190 200 210 220 230

Qt — Principally surfaces on gravels, some on Lake Missoula lacustrine deposits and some on bedrock

pεw — Interbedded, fine-grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'

pεs — Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

pεrb — Undifferentiated quartzites, including Revett and Burke equivalents. Predominantly light-grey impure quartzites, ranging from pure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick

U, ↑65, D — Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side

Zone of shearing

60 — Strike and dip of beds

SCALE
HORIZONTAL 0 100 200 400 FEET

EXHIBIT NO. — 48
GEOLOGY
"A" LINES
STAS. 240+00 — 310+00

p€w

p€rb

Qf

"A7" LINE

240

250

260

270

280

290

300

310

4°00'

3°30'

Principally surfaces on gravels, some on Lake Missoula lacustrine deposits and some on bedrock

Interbedded, fine grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'

Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

Undifferentiated quartzites, including Revett and Burke equivalents. Predominantly light-grey impure quartzites, ranging from pure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick

Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side

Zone of sheering

Strike and dip of beds

SCALE
HORIZONTAL
0 100 200 400 FEET

EXHIBIT NO.— 49
GEOLOGY
"A" LINES
STAS. 320 + 00 — 380 + 00

p€w
p€s
Qt
"C5" LINE
"C7" LINE
"A7" LINE
310
320
330
340
350
290
300
370
380
3°30'
5°00'
7°00'
316+20 "C7" LINE-BK = 360+60 "A7" LINE-AH
340+00 "C5" LINE-BK = 360+60 "A7" LINE-AH

Qt — Principally surfaces on gravels, some on Lake Missoula lacustrine deposits and some on bedrock

p€w — Interbedded, fine-grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'

p€s — Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

p€ib — Undifferentiated quartzites, including Revett and Burke equivalents. Predominantly light-grey impure quartzites, ranging from impure massive white quartzite to pure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick.

Fault, showing dip, dotted where concealed, U, upthrown side; D, is the downthrown side

Zone of shearing

60 — Strike and dip of beds

SCALE
HORIZONTAL
0 100 200 400 FEET

EXHIBIT NO. — 50
GEOLOGY
"A" LINES
STAS. 390 + 00 — 450 + 00

Qt — Principally surfaces on gravels, some on Lake Missoula locustrine deposits and some on bedrock

p€w — Interbedded, fine-grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'

p€s — Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

p€rb — Undifferentiated quartzites, including Revett and Burke equivalents. Predominantly light-grey impure quartzites, ranging from impure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick

Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side

Zone of shearing

Strike and dip of beds

"A7" LINE

SCALE
HORIZONTAL 0 100 200 400 FEET

EXHIBIT NO. — 51
GEOLOGY
"A" LINES
STAS. 460 + 00 — 520 + 00

p€rb

Qt

480

490

500

510

520

470

460

3°30'

2°00'

"A" LINE

p€s

Principally surfacee on gravels, some on Lake Missoula locustrine deposits and some on bedrock

Interbedded, fine-grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'

Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

Undifferentioted quartzites, including Revett and Burke equivolents. Predominantly light-grey impure quartzites, ranging from pure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick.

Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side

Zone of shearing

Strike and dip of beds

SCALE
HORIZONTAL
0 100 200 400 FEET

EXHIBIT NO. — 52
GEOLOGY
"A" LINES
STAS. 530+00 — 590+00

Qt — Principally surfaces on gravels, some on Lake Missoula lacustrine deposits and some on bedrock

p€rb — Interbedded, fine-grained, light-grey, somewhat flinty quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'

p€s — Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

p€rb — Undifferentiated quartzites, including Revett and Burke equivalents. Predominantly light-grey impure quartzites, ranging from pure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick.

U ↑65? D — Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side

Zone of shearing

60 — Strike and dip of beds

p€rb

Qt

SALTESE

"A" LINE

530 540 550 560 570 580 590

2°00'

SCALE
HORIZONTAL 0 100 200 400 FEET

EXHIBIT NO. — 53
GEOLOGY
" B " LINES
STAS. 0+00 — 60+00

p€rb

p€s

Qt

"B" LINE

"C5" LINE

"C7" LINE

IDAHO

MONTANA

Bonston

2°00'

2°30'

4°00'

3°30'

2°30'

3°30'

0

20

30

40

50

60

65

85

30

Qt — Principally surfaces on gravels, some on Lake Missoula lacustrine deposits and some on bedrock

p€w — Interbedded, fine-grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'

p€s — Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

p€rb — Undifferentiated quartzites, including Revett and Burke equivalents. Predominantly light-grey impure quartzites, ranging from pure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick

U ↑65 ? D — Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side

Zone of shearing

80 — Strike and dip of beds

SCALE
HORIZONTAL
0 100 200 400 FEET

EXHIBIT NO. — 54
GEOLOGY
" B " LINES
STAS. 70 + 00 — 130 + 00

p€rb

D/U

"B-1" LINE

"C5" LINE

"C7" LINE

"B7" LINE

80

90

100

110

120

130

1°00'

2°00'

2°30'

HP 23-2

Qt — Principally surfaces on gravels, some on Lake Missoula lacustrine deposits and some on bedrock

p€m — Interbedded, fine-grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'

p€s — Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

p€rb — Undifferentiated quartzites, including Ravell and Burke equivalents. Predominantly light-grey impure quartzites, ranging from pure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick

Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side

Zone of shearing

Strike and dip of beds

SCALE
HORIZONTAL 0 100 200 400 FEET

EXHIBIT NO.— 55
GEOLOGY
"B" LINES
STAS. 140 + 00 — 200 + 00

Qt — Principally surfaces on gravels, some on Lake Missoula lacustrine deposits and some on bedrock

pЄw — Interbedded, fine-grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'

pЄs — Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

pЄrb — Undifferentiated quartzites, including Revett and Burke equivalents. Predominantly light-grey impure quartzites, ranging from pure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick

Fault, showing dip, dotted where concealed, U, up thrown side, D, is the down thrown side

Zone of shearing

Strike and dip of beds

pЄrb

156+00 "B7" LINE - BK
156+00 "B5" LINE - AH

"C5" LINE

"C7" LINE

"B5" LINE

"B7" LINE

140 150 160 170 180 190 200

2°00' 3°30' 2°30' 7°00' 3°00' 1°00'

SCALE
HORIZONTAL 0 100 200 400 FEET

EXHIBIT NO. — 56
GEOLOGY
"B" LINES
STAS. 210 + 00 — 270 + 00

"B5" LINE
"B7" LINE
210
220
230
240
250
260
270
280
1°00'
3°30'
4°00'
p€rb
Qt
F

Qt — Principally surfaces on gravels, some on Lake Missoula lacustrine deposits and some on bedrock

p€w — Interbedded, fine-grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'

p€s — Predominantly greenish-grey, thinly laminated and bonded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

p€rb — Undifferentiated quartzites, including Revett and Burke equivalents. Predominantly light-grey impure quartzites, ranging from impure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick

Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side

Zone of shearing

Strike and dip of beds

SCALE
HORIZONTAL
0 100 200 400 FEET

EXHIBIT NO. — 57
GEOLOGY
" B " LINES
STAS. 290 + 00 — 360 + 00

N

"B5" LINE

"B7" LINE

Qt

pЄrb

pЄw

FAULT CONTACT

Principally surfaces on gravels, some on Lake Missoula lacustrine deposits and some on bedrock

Interbedded, fine-grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some graywackes are common in lower 1000'

Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

Undifferentiated quartzites, including Revett and Burke equivalents. Predominantly light-grey impure quartzites, ranging from impure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick

Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side

Zone of shearing

Strike and dip of beds

SCALE
HORIZONTAL
0 100 200 400 FEET

EXHIBIT NO. — 5B
GEOLOGY
"B" LINES
STAS. 370 +00 — 430 +00

Qt — Principally surfaces on gravels, some on Lake Missoula lacustrine deposits and some on bedrock

pЄs — Interbedded, fine-grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'

pЄs — Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

pЄrb — Undifferentiated quartzites, including Revell and Burke equivalents. Predominantly light-grey impure quartzites, ranging from pure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick

U, D, ↑65? — Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side

Zone of shearing

60 — Strike and dip of beds

p€rb

Qt

FAULT CONTACT

"B5" LINE

"B7" LINE

380 390 370 400 410 420 430

80 90 50 70

2°00' 4°00' 5°00' 6°00'

427 + 70 BK "B5" LINE
413 + 40 AH "B7" LINE

SCALE
HORIZONTAL 0 100 200 400 FEET

EXHIBIT NO. — 59
GEOLOGY
"B" LINES
STAS. 440 + 00 — 590 + 00

Qt — Principally surfaces on gravels, some on Lake Missoula lacustrine deposits and some on bedrock

pЄw — Interbedded, fine-grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'

pЄs — Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

pЄrb — Undifferentiated quartzites, including Revett and Burke equivalents. Predominantly light-grey impure quartzites, ranging from pure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick

U ↑65? D — Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side

Zone of shearing

Strike and dip of beds

SCALE
HORIZONTAL 0 100 200 400 FEET

EXHIBIT NO. — 60
GEOLOGY
"C" LINES
STAS. 170+00 — 220+00

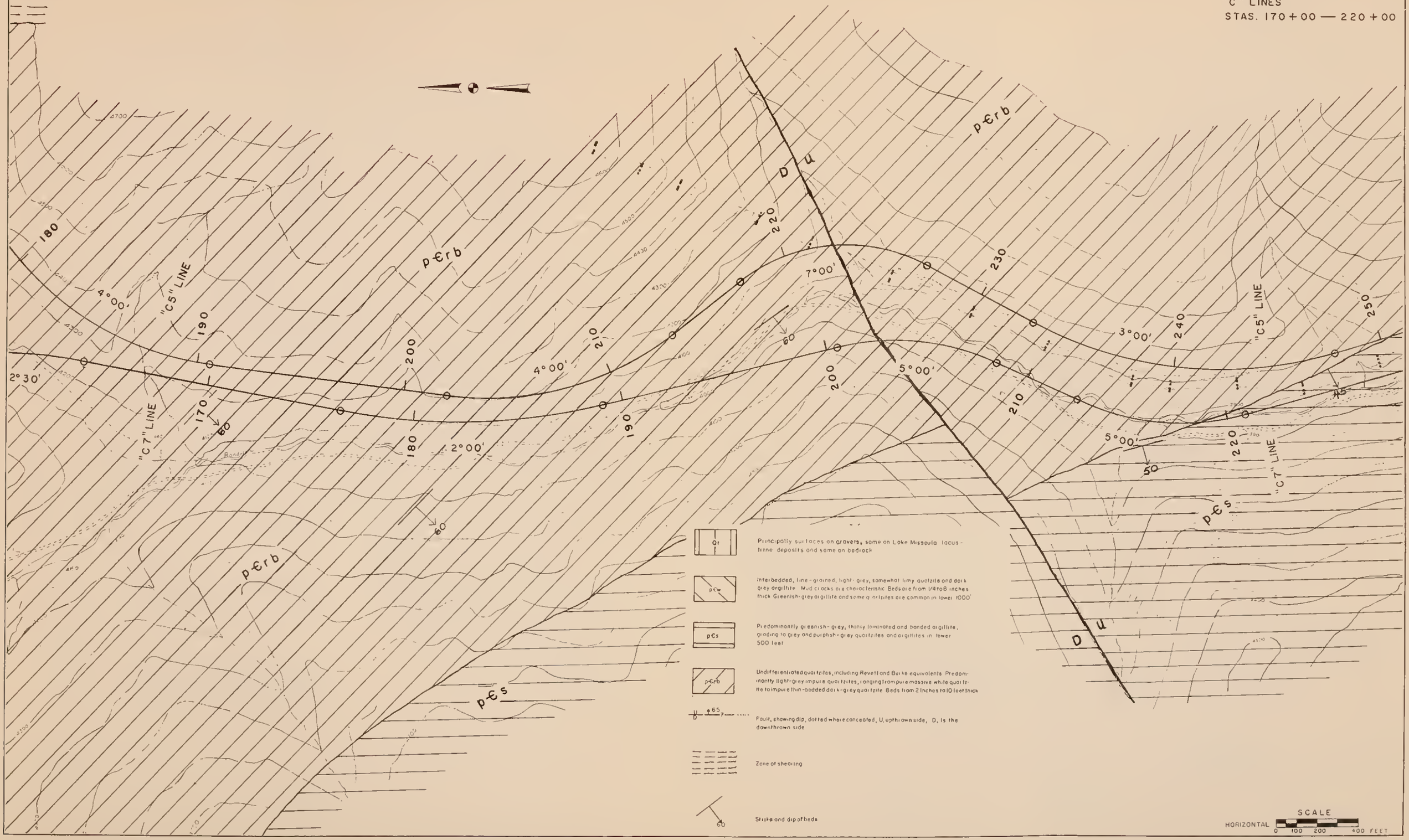

"C5" LINE
"C7" LINE
"C7" LINE
"C5" LINE
180
190
200
210
220
230
240
250
170
60
45
50
4°00'
2°30'
2°00'
5°00'
7°00'
3°00'
pεrb
pεs
D
U
Qt
Principally surfaces on gravels, some on Lake Missoula lacustrine deposits and some on bedrock
Interbedded, fine-grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'
Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet
Undifferentiated quartzites, including Revett and Burke equivalents. Predominantly light-grey impure quartzites, ranging from pure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick
Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side
Zone of shearing
Strike and dip of beds
SCALE
HORIZONTAL
0 100 200 400 FEET

EXHIBIT NO. — 61
GEOLOGY
"C" LINES
STAS. 230+00 — 320+00

"C5" LINE

"C7" LINE

Qt — Principally surfaces on gravels, some on Lake Miekpula lacustrine deposits and some on badrock

pεw — Interbedded, fine-grained, light-grey, somewhat limy quartzite and dark grey argillite. Mud cracks are characteristic. Beds are from 1/4 to 8 inches thick. Greenish-grey argillite and some quartzites are common in lower 1000'

pεs — Predominantly greenish-grey, thinly laminated and banded argillite, grading to grey and purplish-grey quartzites and argillites in lower 500 feet

pεrb — Undifferentiated quartzites, including Revett and Burke equivalents. Predominantly light-grey impure quartzites, ranging from pure massive white quartzite to impure thin-bedded dark-grey quartzite. Beds from 2 inches to 10 feet thick.

Fault, showing dip, dotted where concealed, U, upthrown side, D, is the downthrown side

Zone of shearing

Strike and dipot beds

SCALE
HORIZONTAL
0 100 200 400 FEET